HSL No. 77-02
February 1977

Highway Safety Literature

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AUTOMOBILE CONSUMER INFORMATION CRASH TEST PROGRAM, VOL. I

by

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ABSTRACT

The objectives of this program were to generate experimental test data on recent intermediate size automobiles in the areas of damage susceptibility, crashworthiness, and repairability, and to demonstrate the capability of existing simulation models for predicting the dynamic responses of the vehicles and occupants. The full-scale crash testing program included frontal barrier and car-to-car front-to-side and front-to-rear impacts in 22 tests of 1973 and 1974 models of Plymouth Satellite and Ford Torino vehicles. The vehicle structure and occupant computer models are briefly described and comparisons of simulated and actual crash test results are presented. The methodology of static crush tests that were performed to obtain data on the force-deflection properties of the major vehicle structural components for input to the vehicle response models is also briefly described.

I. INTRODUCTION

In the belief that legislation was need to foster competition among automobile manufacturers in order to promote the construction of less fragile, safer, and more easily repairable motor vehicles, Congress enacted Public Law 92-513 known as the "Motor Vehicle Information and Cost Savings Act" in October 1972. Title II of the Act, "Automobile Consumer Information Study," directs the Secretary of Transportation to conduct a comprehensive study of the methods of determining passenger motor vehicle characteristics concerning damage susceptibility, degree of crashworthiness, and ease of diagnosis and repair of systems or components that fail during use or which are damaged in accidents. The ultimate purpose of the study is to establish a means of providing pertinent information in these areas to aid the consumer considering the purchase of an automobile. It is hoped that enabling consumers to be better informed would result in increased demand for, and hence incentive for manufacturers to build, motor vehicles that rate high in these three important areas of concern.

Accordingly, the NHTSA contracted with the General Electric Company (Contract DOT-HS-1-00903) to conduct the Automobile Consumer Information Study (ACIS). In addition, two essentially parallel crash test programs in support of that study were performed for the NHTSA by the Dynamic Science Division of Ultrasystems, Inc. and Calspan. Vehicles tested by Dynamic Science were 1973 and 1974 model General Motors Chevelles and American Motors Matadors, whereas those tested by Calspan were similarly intermediate sizes 1973 and 1974 Plymouth Satellites and Ford Torinos.

This report documents Calspan efforts in a combined experimental and analytical research program to provide supporting data useful to the accomplishments of the overall ACIS project. The major thrust of the effort was aimed at generating data on the recent model automobiles in the areas of damage susceptibility, crashworthiness, and repairability from experimental crash tests that are briefly described herein. Complete documentation and the data from these experiments have been previously presented in separate individual test reports. However, the program also included analytical studies in which existing computer simulation models for predicting the dynamic responses of both the vehicle structure and the vehicle occupants were applied. The objective of the simulation tasks was to compare predictions from the models with responses measured in the Phase II (1974 models) automobile crash tests in order that the utility of such analytical predictive techniques with respect to the objectives and needs of the ACIS investigation might be evaluated.

II. TEST PROGRAM SUMMARY

A total of 22 full scale vehicle crash tests were conducted in the overall test program which consisted of

two separate phases. The first (Phase I) series of tests employed 1973 model intermediate size passenger cars made by two different manufacturers, i.e., 1973 Ford Torinos and 1973 Plymouth Satellites. The same two car models were used in the Phase II tests except that they were 1974 vehicles.

Ten tests that included 15 and 30 mph collisions against a fixed rigid barrier, 20 mph car-to-car, front-to-side, and front-to-rear impacts, and 15 mph rear impacts by a moving rigid barrier were performed in Phase I. The 1974 model vehicles in the Phase II test programs were subjected to 8, 25, 30, and 35 mph collisions with the rigid barrier and front-to-rear impacts of cars of the same make in which the rear of the stationary target vehicle was struck by the other car at speeds of 10 and 20 mph. Individual test reports were published during the course of the research project; the test configurations and corresponding reports are listed in Tables 1 and 2 for the Phase I and Phase II tests, respectively.

A large complement of instrumentation was employed to measure and record the impact responses of the vehicles and of the two 50th percentile male anthropomorphic dummy occupants of each automobile. Between 12 and 19 accelerometers were mounted

Table 1

PHASE I TEST PROGRAM

Test No.	*Vehicle Model* *	*Impact Velocity MPH*	*Test Condition*	*Calspan Report No.*
1	C1	15	Frontal Barrier	ZT-5561-V-3
2	D1	15	Frontal Barrier	ZT-5561-V-4
3	C2	30	Frontal Barrier	ZT-5561-V-5
4	D2	30	Frontal Barrier	ZT-5561-V-6
5	C1	20	Front to	
	C3	0	Side	ZT-5561-V-7
6	D1	20	Front to	
	D3	0	Side	ZT-5561-V-8
7	C3	20	Front to	
	C1	0	Rear	ZT-5561-V-9
8	D3	20	Front to	
	D1	0	Rear	ZT-5561-V-10
9	MB	15	Front to	
	C2	0	Rear	ZT-5561-V-11
10	MB	15	Front to	
	D2	0	Rear	ZT-5561-V-12

* C Series—1973 Ford Torino
* D Series—1973 Plymouth Satellite

Table 2

PHASE II TEST PROGRAM

Test No.	*Vehicle Model* *	*Impact Velocity MPH*	*Test Condition*	*Calspan Report No.*
1	D1	8	Frontal Barrier	ZT-5561-V-14
2	D2	10	Front to	
	D3	0	Rear	ZT-5561-V-15
3	D3	20	Front to	
	D2	0	Rear	ZT-5561-V-16
4	C1	8	Frontal Barrier	ZT-5561-V-17
5	C2	10	Front to	
	C1	0	Rear	ZT-5561-V-18
6	C3	20	Front to	
	C2	0	Rear	ZT-5561-V-19
7	D1	25	Frontal Barrier	ZT-5561-V-20
8	C1	25	Frontal Barrier	ZT-5561-V-21
9	D2	30	Frontal Barrier	ZT-5561-V-22
10	C2	30	Frontal Barrier	ZT-5561-V-23
11	D3	35	Frontal Barrier	ZT-5561-V-24
12	C3	35	Frontal Barrier	ZT-5561-V-25

* C Series—1974 Ford Torino
* D Series—1974 Plymouth Satellite

on the cars for measurement of the impact accelerations. Other electronic instrumentation included load cells which measured the longitudinal forces exerted on the face of the barrier during crushing of the vehicle forward structure in the fixed barrier tests, transducers to measure the loads developed in the belts of type 2 restraint systems provided in the cars with which the test dummies were restrained, triaxial accelerometers mounted in the head and chest of the dummies, and load cells to measure the dummy femur forces. In addition, from 6 to 10 high speed cameras as well as still photography were used to obtain a permanent visual record of each crash test.

Following each test, measurements of the amount of permanent crush of the vehicle structure were made and the vehicle damage index (VDI) rating was determined by Calspan multidisciplinary accident investigation personnel. In addition, estimates of repair costs were obtained from two independent automotive damage appraisers. This information, together with other data derived from the test records of vehicle and occupant responses, is summarized for the two makes of automobiles, subjected to nearly identical test conditions, in Tables 3 and 4 for the Phase I and

It is noted that, except for the 30 mph fixed barrier tests, the occupant responses in each of the Phase I tests were not severe and much below the FMVSS 208 injury criteria levels. For this reason, uninstrumented dummies were used in all of the Phase II vehicle tests except the 25, 30, and 35 mph frontal fixed-barrier crashes.

The individual test reports listed in Tables 1 and 2 should be consulted for complete and detailed descriptions and results of the various tests performed. These reports contain information on the location of the various accelerometers installed in the vehicles; the type and location of high speed cameras, pre- and post-test vehicle dimensions; diagrams, descriptions, and photographs of damage; results of dummy certification tests performed in accordance with procedures described in 49 CFR Part 572; detailed appraisals of repair costs; and time history plots of the reduced data from all of the electronic instrumentation, including vehicle velocity and displacement time histories based on integrations of the measured vehicle decelerations.

III. COMPUTER SIMULATIONS

Part of the Calspan Consumer Information Project effort involved the application of existing computer simulation models to obtain predictions of the dynamic responses of the 1974 model Ford and Plymouth automobiles and the anthropomorphic dummy occupants prior to the performance of the Phase II crash tests. The primary objective of these simulations was to compare the predicted responses with the actual test results and to assess the feasibility of using such analytical techniques as a means of economically generating vehicle crash performance data, thereby reducing the need for experimental testing. Secondly, since the crash tests were also independently simulated

Table 3

SUMMARY OF PHASE I TESTS OF 1973 AUTOMOBILES

A. VEHICLE RESPONSES

Test Configuration	Impact Speed MPH	ΔV MPH	Impact Duration Sec.	Max. Accel. In Impact Direction G	Max. Dynamic Crush In.	Permanent Crush In.	Vehicle Damage Index	Est. Repair Cost * $ #1	#2
FRONTAL-FIXED BARRIER									
Ford	14.82	18.6	.150	18.8	12.5	7.0	N/A	1618.73	1237.50
Plymouth	14.93	18.2	.130	24.3	8.8	5.3	12FCEW1	742.25	702.38
Ford	30.05	33.1	.120	40.0	30.0	25.0	12FDEW2	3993.90	2626.02
Plymouth	30.17	38	.140	44.0	22.4	21.8	12FDEW2	3564.82	2946.42
CAR-TO-CAR, FRONT/SIDE									
Ford (Bullet)	20.37	12.8	.135	10.0	17.5	8.0	12FDEW1	800.25	1226.15
Ford (Target)	0	11.0		8.7	(mutual)	8.0	09LPEW2	1120.10	819.10
Plymouth (Bullet)	20.47	12.6	.145	13.3	14.3	5.0	12FDEW1	579.90	665.65
Plymouth (Target)	0	12.0		10.2	(mutual)	10.5	09LPEW2	1189.94	1034.19
CAR-TO-CAR, FRONT/REAR									
Ford (Bullet)	19.88	12.9	.135	12.8	13.5	4.7	12FDEW1	833.80	653.59
Ford (Target)	0	11.2		10.3	(mutual)	2.3	06BDEW1	753.95	884.80
Plymouth (Bullet)	20.38	11.6	.150	15.1	19.3	0.5	—	163.53	180.95
Plymouth (Target)	0	10.5		10.5	(mutual)	14.4	06BDEW2	1361.04	1466.88
REAR-MOVING BARRIER									
Ford	14.56	7.2	.085	7.9	9.4	8.0	06BDEW2	874.40	1005.20
Plymouth	14.66	7.1	.090	9.0	8.9	6.6	06BDEW1	911.39	731.42

* Repair costs based on $10 per hour labor rate and no sales tax.

Table 3—(Continued)

SUMMARY OF PHASE I TESTS OF 1973 AUTOMOBILES

B. OCCUPANT RESPONSES

Test Configuration	Impact Speed MPH	DRIVER Max. Res. Head Accel. G	HIC	Max. Res. Chest Accel. G	CSI	Right Femur Load Lb.	Left Femur Load Lb.	PASSENGER Max. Res. Head Accel. G	HIC	Max. Res. Chest Accel. G	CSI	Right Femur Load Lb.	Left Femur Load Lb.	Seat Location
FRONTAL-FIXED BARRIER														
Ford	14.82	21	82	24.7	64	380	720	22.5	107	21.5	67	560	380	RF
Plymouth	14.93	31.5	134	21.5	70	700	160	40.5	128	20.4	61	150	120	RF
Ford	30.05	73	535	46	324	580	760	60	707	39	269	620	330	RF
Plymouth	30.17	56	487	36	278	1350	320	50	571	36	243	850	1050	RF
CAR-TO-CAR, FRONT/SIDE														
Ford (Bullet)	20.37	13.4	33	13	24	–120	–75	10.9	22	12.6	20	–113	–90	RF
Ford (Target)	0	18.5	59	40	56	55	64	63	166	37	68	–75	220	LR
Plymouth (Bullet)	20.47	14	36	15.4	28	–80	130	14	36	15	27	–125	–100	RF
Plymouth (Target)	0	25.5	50	60	111	280	–490	22.5	37	51	106	–400	750	LR
CAR-TO-CAR, FRONT/REAR														
Ford (Bullet)	19.88	13.2	33	14.8	26	40	160	14	31	14.4	25	130	300	RF
Ford (Target)	0	27	39	10	15	220	180	46	85	25	38	140	150	RR
Plymouth (Bullet)	20.38	10.4	18	11.4	84	–90	–75	10	16	11.4	14	–95	85	RF
Plymouth (Target)	0	18.8	49	10	14	65	65	41	79	14.5	23	135	180	RR
REAR-MOVING BARRIER														
Ford	14.56	16.8	20	8.5	6	90	90	18	21	14	12	75	50	RR
Plymouth	14.66	13.5	22	7.2	10	75	75	32	45	15.2	16	85	40	RR

by Dynamic Science using different techniques, it afforded the NHTSA an opportunity to evaluate, at least in a preliminary manner, which of the simulation models used by the two research organizations might be better suited for that purpose. Detailed descriptions of the computer models, the methodology for determining input parameters, sample input data, and comparisons of predicted and experimental responses are contained in volume II of this report (Ref. 1).

Simulation of Vehicle Responses

The computer programs used to obtain predictions of vehicle crash responses were a frontal fixed barrier impact model (BASHSIM) and a moving rigid barrier rear impact model (REARIMP). The modeling technique for both programs is similar in that the vehicle structure is represented as a system of lumped undeformable masses and interconnecting springs or resistance elements. The force-deflection properties of the springs were determined from static crush tests of the various vehicle structural components, and modified within the computer programs by an empirical logarithmic function to account for dynamic strain rate effects. It is essential, of course, that collapse modes of the various structural elements in the static crush tests be the same as those which occur under dynamic crash conditions. This requires considerable experience in full-scale dynamic testing to ascertain what the collapse modes are as well as static crush testing to provide suitable load reacting fixture configurations.

Table 4

SUMMARY OF PHASE II TESTS OF 1974 AUTOMOBILES

A. VEHICLE RESPONSES

Test Configuration	Impact Speed MPH	ΔV MPH	Impact Duration Sec.	Max. Accel. In Impact Direction G	Max. Dynamic Crush In.	Permanent Crush In.	Vehicle Damage Index	Est. Repair Cost * $ #1	Est. Repair Cost * $ #2
FRONTAL-FIXED BARRIER									
Ford	8.13	10.1	.170	7.0	6.8	1.3	12FCEN1	373.47	284.71
Plymouth	8.15	9.7	.140	12.5	5.7	1.5	12FCLN1	10.23	15.35
Ford	25.46	28.5	.136	25.2	26.5	22.1	12FDAW6	1684.07	2273.47
Plymouth	24.74	29.3	.129	28.0	15.9	10.8	12FDAW5	2304.94	2266.93
Ford	30.35	31.3	.147	34.0	31.5	26.0	12FDAW6	2589.81	2904.65
Plymouth	30.49	35.9	.122	29.8	21.3	16.3	12FDAW6	2839.50	2893.13
Ford	35.21	39.4	.147	51.0	34.4	30.5	12FDAW6	4243.46	3743.92
Plymouth	34.86	36.9	.139	63.2	30.0	24.0	12FDAW6	3382.78	3621.54
CAR-TO-CAR, FRONT/REAR									
Ford (Bullet)	9.99	6.5	.150	4.5	9	0.5	12FCLN1	111.82	106.82
Ford (Target)	0	7.0		5.0	(mutual)	1.0	06BCLN1	85.99	88.99
Plymouth (Bullet)	9.77	5.8	.110	12.3	5	0.25	12FCLN1	51.13	92.51
Plymouth (Target)	0	4.5		9.2	(mutual)	0.75	06BCLN1	107.25	93.24
Ford (Bullet)	19.10	13.3	.165	8.8	17	3.5	12FDEW1	457.65	439.01
Ford (Target)	0	9.9		8.0	(mutual)	1.5	06BDLW1	326.60	217.78
Plymouth (Bullet)	19.29	11.8	.125	22.3	14	1.5	12FCLN1	118.36	64.03
Plymouth (Target)	0	8.8		11.8	(mutual)	2.5	06BDEW5	1056.31	664.19

* Repair costs based on $11 per hour labor rate, new parts, labor and parts discounted @ 15%, and 7% sales tax on parts and labor.

Table 4—(Continued)

SUMMARY OF PHASE II TESTS OF 1974 AUTOMOBILES

B. OCCUPANT RESPONSES

		DRIVER						PASSENGER					
Test Vehicle	Impact Speed MPH	Max. Res. Head Accel. G	HIC	Max. Res. Chest Accel. G	CSI	Right Femur Load Lb.	Left Femur Load Lb.	Max. Res. Head Accel. G	HIC	Max. Res. Chest Accel. G	CSI	Right Femur Load Lb.	Left Femur Load Lb.
Ford	25.46	49	310	28.5	155	280	760	62	358	28.5	165	540	400
Plymouth	24.74	56	351	34	180	N/A	410	38.5	314	33.5	156	300	450
Ford	30.35	62	444	41.5	232	1250	670	58.5	520	35.5	242	1100	600
Plymouth	30.49	70	594	50	259	1065	264	48	456	31.5	199	640	400
Ford	35.21	80	1188	88	673	2600	900	103	906	60	506	675	1200
Plymouth	34.86	76.5	909	54	451	N/A	560	N/A	N/A	N/A	N/A	540	900

Table 5

COMPARISON OF PREDICTED AND MEASURED VEHICLE RESPONSE DATA FOR FRONTAL FIXED BARRIER IMPACTS

		1974 FORD TORINO				*1974 PLYMOUTH SATELLITE*			
		8 MPH	*25 MPH*	*30 MPH*	*35 MPH*	*8 MPH*	*25 MPH*	*30 MPH*	*35 MPH**
Peak Accel.. G	P	10.9	22.8	28.4	33.7	11.1	23.5	26.9	27.7
	E	7.0	25.2	34.0	51.0	12.5	28.0	29.8	63.2
Time of Peak G. m'sec	P	53.2	43.0	78.4	65.0	15.1	53.7	64.6	57.0
	E	39	90	72	68	12	29	24	49
Time to Zero Velocity, m'sec	P	56.3	81.9	85.4	92.2	61.6	61.0	68.0	78.2
	E	85	100	95	90	67	78	83	100
Total Crush, in.	P	5.3	21.4	27.9	33.9	4.7	15.7	20.8	27.2
	E	6.8	26.5	31.5	34.4	5.7	15.9	21.3	30

* Experimental Values from Single Accelerometer on Drive Line Tunnel
P—Prediction
E—Experimental

The frontal impact model is a three-degree-of-freedom system consisting of three masses and eight resistance elements. The lumped masses represent the engine and transmission. the front suspensions. wheels and crossmember. and the remaining weight of the vehicle. The resistance elements for which force-deflection data are required are: forward and aft portions of the front frame rails. sheet metal. driveline. dash. radiator. and engine and transmission mounts.

The rear impact model is a five-degree-of-freedom system consisting of five masses. one of which represents the moving barrier. and 10 resistances. The vehicle masses are the engine and transmission. rear axle. gas tank. and the remaining weight of the vehicle. The resistances in this case include the forward and aft portions of rear frame rails. fuel tank and rear leaf springs. the driveline. rear sheet metal. and the engine and transmission mounts. Only a few simulations using the REARIMP computer program were made because moving barrier tests were not included in the Phase II test program. and hence no experimental data were available for direct comparison with the predicted responses.

Some of the model and test results are summarized in Table 5. It may be seen that the total crush of the vehicles over the range of impact speeds was predicted quite well. However. the model results for the peak acceleration are much lower than the measured values in the 35 mph tests and the correlation of the time at which the maximum acceleration occurs is poor in several instances.

At the request of the NHTSA. the values of a factor called the "Normalized Mean Square Error" (NMSE) to be used for evaluating the correlation between the model predictions and experimental measurements of passenger compartment accelerations were determined. The NMSE is defined by the following expression:

$$\text{NMSE} = \frac{\int_0^t [E(r) - P(r)]^2 \, dr}{\int_0^t E(r)^2 \, dr} \quad \text{d}$$

Where E = Experimental acceleration and
P = Predicted acceleration

The values of the above function evaluated at the corresponding maximum time period of each of the eight frontal barrier impacts (i.e.. when the predicted passenger compartment forward velocity is reduced to zero) are given in Table 6.

It is our understanding that for the purpose of this research program. the predictive capability is considered good when the NMSE is less than 0.5 and poor when the value is greater than 1.0. As may be seen from the table. the NMSE exceeds 0.5 only in the case of the Plymouth at 35 mph for which the quality of the test data was not as good as the other tests. Tabu-

NORMAL MEAN STANDARD ERROR OF VEHICLE RESPONSE PREDICTION

Barrier Impact Velocity, MPH	*NMSE*	
	1974 Satellite	*1974 Torino*
8	.26	.34
25	.16	.42
30	.29	.12
35	.58	.16

lations of the time history variation of the NMSE calculated for one-millisecond time intervals are contained in volume II of this report (Ref. 1).

Simulation of Occupant Responses

Predictions of occupant dynamics were obtained with a three-dimensional crash victim simulation computer program developed by Calspan (References 2 and 3). Inputs to the program include parameters that describe the physical characteristics of the crash victim, the geometry and material properties of vehicle interior surfaces and restraints with which the occupant may come in contact, and the time history of vehicle deceleration.

Part of the data required for modeling the Humanoid Systems 50th percentile anthropomorphic test dummies used in the tests were obtained directly from the NHTSA drawings referenced in test dummy regulation 49 CFR Part 572; other input data were estimated based on measurements of similar dummies reported in References 3, 4, and 5.

The interior of the vehicles was measured to define the location of the restraint belt anchor points and the geometry of surfaces that might be contacted by the occupant during the crashes. The outline of the vehicle interior was modeled by nine planar contact panels representing the seat cushion; seat back; floor; toeboard; lower, middle, and upper dash; windshield; and the roof. For the simulations of the driver, an additional contact panel representing the steering wheel was included. Calspan measurements of the static force-deflection characteristics of vehicle interior components that were obtained in tests defined by Dynamic Science to provide proper inputs to their occupant response model were also used for the Calspan simulations of the Plymouth and Ford crash tests. However, since it was expected that the legs of the test dummies might contact the lower surfaces of the instrument dash panel, some additional static tests data for possible contacts in those areas.

Predictions of the dummy responses were obtained using input data for the vehicle deceleration time histories from two sources. For the first set of simulations, which were completed before the full-scale tests were conducted, the vehicle decelerations predicted by the BASHSIM computer model were used. The simulations were then repeated with the vehicle deceleration data measured during the first 150 milliseconds of the actual crash tests (i.e., including vehicle rebound) as the input to the crash victim computer program.

Analysis of the data for all of the tests indicates that discrepancies between the analytical and test results are in large measure due to shortcomings in simulating the behavior of the belt restraint system. The simulated shoulder belt loads at the upper end of the belt are much greater than those measured in the tests; consequently, the predicted chest acceleration responses increase rapidly to peak values that are substantially higher than the measured responses which are of longer time duration. This in turn causes the heads of the simulated dummies to snap forward at higher acceleration levels and with a more rapid rate of onset.

Results of all of the occupant simulations in terms of various injury criteria are summarized in Tables 7 and 8, together with the values measured in the tests. Comparison of the two sets of predictions for each vehicle shows that the Plymouth occupant responses were much more affected than those for the Ford by the use of vehicle deceleration data measured in the tests rather than the decelerations predicted by the structural dynamics model. This could be due to the fact that the vehicle decelerations predicted by the structural model agreed more closely with the experimental responses of the Ford than they did in the case of the Plymouth. On the other hand, it is possible that some other factor such as differences of the overall shape of the vehicle deceleration response for the two makes of automobile or perhaps the different stiffnesses of the restraint belts* effectively caused the simulated Plymouth occupants to be more sensitive to changes of vehicle deceleration input.

In general, use of test data for the vehicle deceleration time histories appears to have produced somewhat better agreement between the predicted and measured occupant responses but the differences still vary from only a small amount in some instances to a rather large discrepancy in others. For both vehicles, the

* Data from static tests of the belts showed the stiffness of the Plymouth belt webbing to be twice that of the Ford.

predicted values of the HIC (head injury criterion) number and HSI (head severity index) are usually lower than those measured in the experiments whereas the opposite is true in the comparisons of the chest severity indices.

Based on the present state of the art, the most proper approach to assessing the feasibility of using analytical predictive techniques to aid evaluation and rating of vehicle crashworthiness characteristics is the consideration of whether any trends that may be observed

Table 7

SUMMARY OF PREDICTED AND EXPERIMENTAL OCCUPANT RESPONSES
1974 PLYMOUTH SATELLITE

	DRIVER								
	25 MPH			*30 MPH*			*35 MPH*		
	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2
Head Injury Criterion	467	351	328	745	594	372	902	909	384
Head Severity Index	540	450	385	851	750	430	1020	1170	468
Chest Severity Index	558	180	362	778	259	374	832	451	438
Right Femur Max. Force ~ Lb.	277	NA	211	332	1065	235	327	NA	228
Left Femur Max. Force ~ Lb.	347	410	300	421	264	323	421	560	316
	PASSENGER								
	25 MPH			*30 MPH*			*35 MPH*		
	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2
Head Injury Criterion	458	314	306	807	456	382	963	NA	383
Head Severity Index	532	375	362	920	560	443	1078	NA	465
Chest Severity Index	555	156	354	811	199	393	841	NA	434
Right Femur Max. Force ~ Lb.	370	300	336	410	640	345	408	540	346
Left Femur Max. Force ~ Lb.	329	450	289	361	400	300	358	900	301

Notes:

1. P_1—Predicted results using predicted vehicle deceleration.
2. P_2—Predicted results using vehicle deceleration measured in crash test (including rebound).
3. Severity Indices evaluated at 150 milliseconds.
4. Predicted femur force is component normal to vehicle surface contacted by knee and hence is not necessarily along femur axis.

results of the simulations. Analysis of the test data presented in Tables 7 and 8 reveals that, for both makes of vehicles, there is little difference between the values measured for the driver and the front passenger

tion results for the two seat locations are small. The experimental measurements also indicate that the crash performance of the two makes of automobiles is essentially the same and does not allow discrimination

Table 8

SUMMARY OF PREDICTED AND EXPERIMENTAL OCCUPANT RESPONSES 1974 FORD TORINO

	DRIVER								
	25 MPH			*30 MPH*			*35 MPH*		
	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2
Head Injury Criterion	304	310	269	506	444	539	765	1188	829
Head Severity Index	348	413	326	603	592	640	901	1567	959
Chest Severity Index	331	155	239	488	232	509	633	673	756
Right Femur Max. Force ~ Lb.	984	280	611	1200	1250	1200	1200	2600	1200
Left Femur Max. Force ~ Lb.	676	760	484	1200	670	973	1200	900	1200
	PASSENGER								
	25 MPH			*30 MPH*			*35 MPH*		
	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2	P_1	*Exper.*	P_2
Head Injury Criterion	303	358	282	535	520	558	742	906	825
Head Severity Index	356	523	335	633	801	653	871	1407	973
Chest Severity Index	293	165	244	448	242	465	644	506	715
Right Femur Max. Force ~ Lb.	295	540	311	391	1100	395	450	675	424
Left Femur Max. Force ~ Lb.	359	400	351	437	600	423	451	1200	451

Notes:

1. P_1—Predicted results using predicted vehicle deceleration.
2. P_2—Predicted results using vehicle deceleration measured in crash test (including rebound).
3. Severity Indices evaluated at 150 milliseconds.
4. Predicted femur force is component normal to vehicle surface contacted by knee and hence is not necessarily along femur axis. Limited to 1200 lb. for driver simulations by available static test data.

with respect to the safety protection afforded the occupants in collisions at a given speed. Again, this confirms the findings based on the predictions of the occupant simulations. Finally, the expected trend of occupant responses with increases of test speed that is evident from the experiments is likewise demonstrated by the model. Furthermore in this regard it may be noted that the correlation between prediction and experiment of the magnitude of the response changes that result from the changes of impact speed is generally quite good.

IV. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations were developed from results of the experimental crash testing and mathematical modeling efforts applied in the research program described in this report.

1. Much of the requested data generated within the crash test program are regarded as being of little or no value for comparative evaluations and rating of vehicle collision performance. These data include, for example, measurements of vehicle acceleration responses at locations where considerable local deformations occurred and the integration of these as well as occupant accelerations to provide time history plots of velocity and displacements, for all of which the significance of the results is difficult to interpret. Data requirements for achieving the test objectives should be given more consideration in future test programs in order to minimize the instrumentation installation and data processing costs and thereby increase the cost effectiveness of the full-scale crash tests.

2. Side and rear impact testing for comparison and ranking of crashworthiness and damageability performance of different vehicle make models should be accomplished with identical "bullet" vehicles such as a moving barrier. The response of the "target" automobile is affected by the crush properties of the striking vehicles, and the latter were different in the car-to-car tests of the two makes of automobiles that were conducted in this program. Hence, the results of the tests cannot be directly compared (i.e., bullet vs. bullet and target vs. target).

3. The crash test data indicate little difference between the two makes of cars with respect to crashworthiness performance but they appear to differ in terms of damageability based on cost-to-repair estimate comparisons.

4. The 5 mph increment between the speeds of the [illegible] be reduced by eliminating one or more of the test speeds. Alternatively, consideration should be given to performing replicate tests in the case of loss of important data or to establish better the validity and repeatability of the experimentally measured responses.

5. The vehicle structure and occupant response simulation efforts described herein must be regarded as inconclusive with respect to having demonstrated the feasibility of using predictive techniques as the basis for evaluation and rating of automobile crashworthiness performance. However, the comparisons of analytical and experimental results do support the conclusion that the models offer considerable potential for economically generating useful data to aid in the evaluation process. Experience in application of the models and particularly in testing against detailed, good quality experimental data is very limited. Hence, they should be used with caution until sufficient experience has been gained to justify confidence in the predictions. Even then, the models should not be viewed as obviating the need for full-scale testing but rather as research tools that can provide additional insights and information to supplement or extrapolate the experimental data. Continued simulation of crash tests that may be conducted in the future is recommended in order that the utility and limitations of the analytical techniques might be more firmly established.

6. The structural models in their present form have no specific provisions for including energy absorbing bumper characteristics although this was done with reasonable success in this effort by including the bumper characteristics with that of the front of the front rails or with the rear of the rear rails for front and rear impacts, respectively. An improvement in the model prediction performance, particularly for low speed collisions, might be achieved by introducing an additional mass and spring element for the bumper.

7. Static test methodology for determination of component force-deflection characteristics for input to the vehicle structural response models requires considerable experience with vehicle structures and collapse modes. To obtain valid static crush test data, it is essential that load reacting test fixtures be provided which will cause the various structural elements to deform in the same manner as the collapse modes experienced in dynamic impact tests.

8. Experiments and exploratory simulations should be conducted to obtain refined values of some of the

of the head response as a measure used in evaluations of vehicle safety.

9. Consideration should be given to modifying the restraint belt algorithm to eliminate the present limitation to either zero or infinite friction between the belts and the occupant. It is believed that relatively minor program changes would be required to obtain more realistic simulation of belt friction effects in controlling the load differential between opposite ends of the belt. By so doing, it is expected that the predictions of upper torso accelerations and kinematic responses would be greatly improved.

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3. Miller, J. Sam, "Performance Evaluation of the General Motors Hybrid II Anthropomorphic Test Dummy," Calspan Report Number ZS-5272-V-1, April 1973.
4. Naab, Kenneth N., "Component Performance Evaluation of a Hybrid II Anthropomorphic Test Dummy," Calspan Report Number ZS-5477-V-1, May 1974.
5. Shoemaker, N. E., Ryder, M. O., and DeLeys, N. J., "Automobile Consumer Information Crash Test Program," Final Technical Report, Calspan Report Number ZT-5561-V-29, December 1975.

ABSTRACT CITATIONS

NHTSA accession number: HS-013 124

Title of document: **MAXIMUM BRAKE PEDAL FORCES PRODUCED BY MALE AND FEMALE DRIVERS**

Abstract: The object of this research was to obtain data concerning th maximum amount of brake pedal force that automobile drive were able to sustain over a period of ten seconds. Subjec were told to apply the brakes in the test car as they would in panic stop, and to exert as much force as possible on th pedal over the entire ten second test period. A total of 84 sul jects were tested, including 42 males and 42 females. Th results indicated that there is a wide distribution of valu which characterizes the pedal force that the subjects were ab to generate. Male subjects produced generally higher force than did females. Over half the women tested were unable exert more than 150 lbs. of force with either foot alone, b when both feet were applied to the pedal, force levels rose si nificantly.

Personal author(s): by C. R. VonBuseck
Corporate author (or author's affiliation): General Motors Corp.
Publication date; pagination: 1973? ; 18p
Supplementary note: Excerpts from Maximum Parking Brake Forces Applied by Male and Female Drivers (EM-23) BY R. L. Bierley, 1965, ar included.
Availability: Availability: Corporate author

NHTSA accession number: HS-013 165

Title of document: **FRICTION MATERIALS, THEIR CHARACTERISTI AND METHODS OF USE IN BRAKES AND CLUTCHES**

Abstract: Properties of woven cotton, woven asbestos, sinter methods, and cerments are given. Reasons for wear and bra fade are described. Different types of brakes and clutches summarized.

Author statement: by Anonymous
Journal citation: Publ: Engineering Materials and Design
Publication date: 1973
Availability: Availability: Engineering Materials and Design v17 n4 p13-7 (Apr 1973)

HS-018 489

ENVIRONMENTAL EFFECTS OF OFF-ROAD VEHICLES. A REVIEW OF THE LITERATURE

Observations and opinions on environmental effects of off-road vehicles (ORV) are separated and reviewed by subject categories, not as a primary information source but rather as a directional device indicating where such types of information may be found. Four forms of literature (scientific papers; reports, meetings, and conferences; periodical articles; and state and miscellaneous publications) are categorized by vehicle. For each vehicle the literature is reorganized into statements on: effects on vegetation; effects on animals; effects on soil; noise; recreational conflicts; controls and legislation; beneficial uses; organizations; and trails. The types of ORV covered in the review include: snowmobiles; motorcycles; minibikes; trail bikes; dune buggies; four-wheel drive vehicles; all-terrain vehicles; hovercraft; amphibious vehicles; and swamp buggies. Characteristic of the literature review is its function in indicating subject areas for specific vehicles in which information is scarce. Some subject areas were preselected for exclusion from the review (health and safety, machine equipment and specifications, recreational uses, and most general information on medical, legal, and technical coverage). Principal detrimental effects noted in the vehicle reviews include: snowmobiles (compaction, noise); motorcycles, minibikes, and trail bikes (erosion, noise); dune buggies and four-wheel drive vehicles (erosion, recreational conflicts, wildlife violations); all-terrain vehicles, hovercraft, amphibious vehicles, and swamp buggies (pollution, wildlife violations, noise). It is concluded from the review that the environmental impacts of ORVs are not well defined currently.

by Norma Jean Lodico
Department of the Interior, Office of Library Services, 19th and C Streets, N.W., Washington, D.C. 20240
Rept. No. DOI-RSB-73-01; PB-226 098; DOI-RSB-73-29; 1973; 121p 103refs
A list of Department of the Interior, Office of Library Services bibliographies comprising 31 items is appended.
Availability: NTIS

HS-019 325

AUTOMOBILE ELECTRONICS. INTERNATIONAL CONFERENCE, 0LONDON0, 6-9 JULY 1976

Papers are presented with illustrative tables, figures, graphic materials, and photographs, and deal with the following topics: automatic headway systems; specifications for electromagnetic compatibility; design and development of futuristic and advanced electronic systems for automobile applications; semiconductors in automotive electronics; automobile testing and diagnosis; radar instrumentation; motorcycle braking; vehicle location; weighing facilities; automatic guidance for road vehicles; handicapped driver vehicles; and status of automobile electronics in the U.S.A., Europe, and Japan. Electronic systems and components of special interest for near-term use in private and commercial vehicles include timing regulation, air cushion control, intrusion alarm, alternator rectifier, voltage regulator, tachometer, climate control, windshield wiper control, wheel lock sensing and control, traction control, clock and amenities regulation, fuel metering, exhaust emissions control, engine performance monitoring and control, automatic transmission control, ignition systems, vehicle instrumentation, driver information systems, cruise and speed control, and anti-glare and headlamp beam control. Overall prognosis for automobile electronics is good provided cost, performance, reliability, and market acceptance limitations are overcome.

Institution of Electrical Engineers, Electronics Div., Savoy Pl., London WC2, England
Rept. No. SAE-P-64; IEE-Conference-Pub-141; 1976; 171p 101refs
Includes HS-019 326--HS-019 361. Conference organized in association with the Institution of Electronic and Radio Engineers, Institution of Mechanical Engineers, and Society of Automotive Engineers.
Availability: SAE

HS-019 326

CURRENT STATUS OF AUTOMOBILE ELECTRONICS IN EUROPE

Principal electronic applications are alternators, electronic flasher control, fuel injection, electronic ignition, controlled-slip braking, automatic transmission, vehicle condition monitoring, and circuit realization. The alternator regulator is currently the only application of electronics likely to be found on European cars of the basic family-sedan category. Higher line models may include electronic tachometers, electronic flashers, and possibly electronic fuel injection and electronic ignition. A few cars also use electronics to operate warning lights, for delayed switching, air-conditioning control, cruise control, and some accessories. Adoption of the electronic alternator on a wide scale resulted from emergence of efficient power diodes capable of withstanding high temperatures and from a demand for increased generator capacity. Higher reliability was realized in volume production and the complete changeover to electronic alternators is seen as assured in the near future. Electronic flasher controls give longer service life than is obtainable from oscillating thermal relay types and can be used for hazard warning and direction indication. Their use is expected to spread progressively, despite a cost disadvantage. Electronic fuel injection systems offer improved engine power, flexibility, and economy. Good running characteristics can be obtained by modulating fuel schedule in response to engine temperatures, and effort will continue to be applied to refining fuel injection technology. Electronic ignition reduces maintenance required and improves stability of timing, with fitment presently confined to cars exported to the U.S. and a few luxury or high-performance cars in Europe. Emission control measures are promoting the adoption of electronic ignition further, utilizing either analog pulse-circuit or digital timing control. Electronic controlled-slip braking, which features self-checking of actuators and sensors, is being considered for adoption in some luxury and high-performance vehicles. Electronic control of conventional automatic transmissions is scheduled for future use in gear-shift timing and shift quality, offering the possibility of additional drive range options, adjustable shift point scheduling, and reduction in gearbox unit size. Vehicle condition monitoring of coolant level, brake fluid and engine oil levels, lamp failure detection, and alternator performance is presently feasible, and is in an early stage of development encouraged by use in commercial vehicles, availability of cheap integrated circuits, legislation, and warranty conditions. Circuit realization by electronics is foreseen, as the need for large quantities or performance

requirements dictate future market and manufacturing decisions, based on considerations of siting, compactness, performance, cost, environmental exposure, and reliability. Overall the use of electronics in automobiles is seen as a measure for reducing fuel and maintenance costs, enabling better warranty conditions, and satisfying legal requirements, with future expansion affected by themes of public policy and economic climate.

by J. E. Maund; W. F. Hill
Lucas Electrical Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p1-4
1976
Conference held in London, 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 327

THE STATUS OF AUTOMOTIVE ELECTRONICS IN THE U.S.A. 0UNITED STATES OF AMERICA0

A general review is provided of four broad, related areas of automotive electronics activities in the U.S.: improving existing electronic and converting electromechanical systems; application of electronics to engine control; application of electronics to new systems; and integrated central computer systems. It is suggested that low-cost transducers and actuators continue to present major barriers to development, but progress is continuing. Long-range developments of systems to assist drivers, such as impaired-driver detector and automatic radar brakes are described. Multiplex wiring systems and digital displays are suggested as shorter-range developments. There is a growing appreciation on the part of automotive engineers for the capability of microprocessors and the flexibility of digital electronics, but the automotive engineer needs to provide more detailed characterization data to support computer modeling and programming in order to fully utilize this capability. Two challenges for the electronics engineer are stated: near-term achievement of cost-effective integrated electronic systems and longer-range development of cost-effective systems to help reduce driver-caused accidents, with particular attention to the drinking driver. Earlier predictions of 10% of the cost of an automobile being represented by electronic systems in the 1980's is considered conservative in view of the applications which are possible and projected.

by Trevor O. Jones
General Motors Proving Grounds, United States of America
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p5-8
1976; 20refs
Conference held in London, 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 328

CURRENT STATUS OF AUTOMOBILE ELECTRONICS IN JAPAN

The current status of automobile electronics in Japan is reviewed with emphasis on exhaust emission regulations. Most research and development in automotive electronics in Japan have been focused on devices and systems relating to emission control. Typical units which have been developed include the semiconductor ignition system, exhaust emission control device, OK monitor (electro-sensor panel), electronic fuel injection system, and intermittent windshield wiper. The ignition system (either breaker-triggered or breakerless) conforms to the severe exhaust emission regulations of Japan, and it prevents the catalytic converter from burning out. The reliability of the system depends on the use of reliable transistors and improved wiring connectors. The exhaust emission control device is regulated by ignition timing in response to engine coolant temperature and vehicle speed, and serves to decrease emission of oxides of nitrogen and hydrocarbons. This control method was generally electronic before 1975, but has become mostly mechanical in action and electronic only in a warning function for abnormal temperatures. U.S. export vehicles also feature electronic control of throttle positioner in response to vehicle speed, spark advance, and EGR valves. A monolithic integrated circuit control based on dual comparators is the preferred configuration. The OK monitor is an on-board diagnostic system which monitors operational functions of automobile components (such as lights and fluid levels) relating to safety, and it warns the driver of malfunctions. Integrated circuits which have passed severe reliability tests are used in the OK system. The electronically controlled fuel injection system utilizes a mass-flow technique to enable direct detection of the intake air volume to meter fuel supply. The intermittent windshield wiper device generally employs molded transistors, applied by either electromagnetic relay or a thyristor, to provide adjustable, intermittent operation. Electric noises from battery charging systems, ignition systems, and electric loads have been studied with the objectives of minimizing or suppressing them in improved systems. Reliability of electronic automotive systems is assured by repeated environmental and use tests and the design and utilization of improved components. Quality control in Japanese electronics is considered an industry standard. The Electronic Advanced Car (EAC) has been developed by Toyota to apply a number of new electronic systems in a practical vehicle. The EAC features solid-state display instruments; on-vehicle computer control of electronic systems such as skid control, automatic transmission, OK monitor, semiconductor ignition, seatbelt interlock, intermittent windshield wiper, air conditioner, and instrumentation; and a signal multiplex system. An automobile comprehensive traffic surveillance system created to transmit current road and traffic conditions information to drivers in progress is also described. A device installed in an individual car can exchange information and data with a data processing control center (computer) via a buried loop antenna and intersection roadside devices. Accelerated development and implementation of such advanced electronic systems for improving convenience, economy, and safety of automobiles are foreseen as improvements in reliability and cost parameters are achieved.

by Takio Kitano; Shingo Ito
Nippondenso Co., Ltd., Japan
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p9-12
1976
Conference held in London, 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 329

ELECTROMAGNETIC COMPATIBILITY SPECIFICATION FOR ELECTRONIC AUTOMOBILE SYSTEMS

Guidelines for the preparation of an electromagnetic compatibility (EMC) specification for motor vehicle systems are presented, specifically two aspects: compatibility of motor vehicles with external environment with special regard to con-

of frequency emissions which can interfere with radio
mmunications and other electronic devices outside the vehi-
and internal compatibility of motor vehicles considered as
compatibility of on-board equipment and systems to be
rated correctly in the intended operational environment at
igned levels of efficiency. The specification procedure
posed considers two criteria groups for applicability: test
hods to cover present and future needs of a large number
motor vehicle types and cost implications related to com-
t tests and rigid limits. Two current specifications are used
bases for the proposed specification: MIL-STD-
A/462/463 (general EMC tests for equipment and systems)
MIL-E-6051D (overall compatibility). Necessary parame-
tested under provision of the specification may include
ablishing a safety margin between susceptibility and inter-
ence in operation of installed equipment, measurement of
EM energy propagated from the device under test
ission tests), and measurement of the spurious response
els of the device under test when subjected to EM energy
sceptibility tests). Testing to ascertain realistic conditions
limitations was carried out in two fields: interference
racterization and susceptibility. Interference characteriza-
was accomplished in terms of alternator load dump
nsient, alternator field decay transient, and ignition system
nsients. Susceptibility tests established criteria for determin-
conducted susceptibility for input loads and for power
ds and for magnetic field and electric field radiated suscep-
lity. Results of the tests showed the necessity of emission
ting on complete motor vehicle systems as well as on com-
ents as a standard for inclusion in specification testing.

B. Audone; L. Bolla; M. Guida; R. Simonetti
ntro Elettronico Avio dell'Aeritalia, Italy; Direzione
ntrale Ricerca della Fiat, Italy
ol: HS-019 325, Automobile Electronics. International
nference, London?, 1976 p13-6
'6; 6refs
nference held in London, 6-9 Jul 1976.
ailability: In HS-019 325

-019 330

MICONDUCTORS FOR AUTOMOTIVE ECTRONICS

e use of semiconductors as components in automotive elec-
nics systems is discussed from the aspect of reliability and
ction as influenced by automotive environmental stresses.
e hard environmental conditions encountered in the automo-
e system (electrical, thermal, mechanical, and climatic)
essitated the development of semiconductors with both
h reliability and low cost. Electrical stress is characterized
high voltage exposure and pulse loading. If several elec-
nic units are used simultaneously, a central supply network
tection (such as power Zener diodes) is advantageous.
ermal stress includes exposure to temperature extremes
ging from -40° C to 120° C in the engine compartment, with
nperature-change cycles occurring each time the engine is
rted and stopped. The temperature variation (level, swing,
l speed) encountered by each single device depends on fac-
s of site, ambient variation near the unit, intrinsic heating,
ver dissipation, and thermal capacity, which can be simu-
ed broadly by a standard temperature change computer pro-
m whose parameters can be matched to installation condi-
ns. Failure analysis under thermal stress has revealed as
st critical those positions where materials with different
efficients of expansion are rigidly connected, dictating
ference for nonencapsulated, symmetrical devices with low
intrinsic heating. Mechanical stress (vibration and shock)
ranges from a few g on bodywork up to 80 g in the engine
area. While design for rigid connections of devices to the units
is the objective, special measures are taken to avoid mechani-
cal resonances. Climatic stress can include moisture, ionic
contaminations, and aggressive gases, all of which can be
avoided by sealing off the electronic unit, component devices,
semiconductor pellets, or the entire system. Examples of reliable
and economic use of semiconductors in automobile elec-
tronic systems are presented, describing the use of rectifier
diodes for alternators, power transistors, and integrated cir-
cuits.

by N. Rittmannsberger
Robert Bosch GmbH, Stuttgart, Federal Republic of Germany
Publ: HS-019 325, Automobile Electronics. International
Conference, London?, 1976 p17-20
1976
Conference held in London, 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 331

AUTOMOBILE ELECTRONICS - CENTRALISED OR DECENTRALISED?

The feasibility of centralizing automobile electronic components into a main unit to offer a more comprehensive vehicle wiring system, improved reliability, ideal servicing conditions, and a reduction in costs was investigated. Three types of components are identified by function: conversion of driver's instructions to signals; control/regulation of engine or individual assembly operations; and aiding/boosting items of electronic accessory equipment (such as the antiskid system). These electronic components are used variously in three categories of automobiles: specially equipped, conventionally equipped per specifications and legislation, and combination equipped with special and regulated components. Special components may include hazard warning flashers, intermittent wiper controls, speed holding devices, auxiliary heater control units, electronic ignition systems, electronic fuel injection, headlight cleaning system control units, and radios with traffic-report decoder. Regulated components may include lighting equipment, hazard systems, or functionally specified equipment. The consequences of centralizing all electronic components, units, and systems in all categories of equipment and automobiles would result in: 100% electronic capacity equipment whether needed or wanted or not; non-optimum location of centralized electronics; redesign of all sensors and switches; high investments for design and manufacturing changes; high costs for the consumer; and automobile manufacturers' obligation or tendency to develop proprietary equipment. In view of these likely results, centralization of automobile electronics is not recommended. Ideal future locations for automobile electronic components are suggested alternatively on the basis of main assemblies which are grouped functionally; one near the driver, one near the power unit (engine), and one or more near special equipment such as an antiskid system (perhaps in the trunk section). Cross-links between electronic assemblies would integrate the overall system for purposes of maintenance and cost control. The desirability for standardization

of basic component groups which could be used in all of a vehicle's electronic clusters is suggested.

by K. Ehlers
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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p21-2
1976
Conference held in London, 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 332

CENTRALIZED ELECTRONIC CONTROL SYSTEM WITH MULTIPLEXING HARNESS

Electric systems of automobiles since 1969 have been analyzed for use in developing a new control system using the latest digital technology and semiconductor technology, called the Centralized Electronic Control System with Multiplexing Harness (CECSMH). The purpose of the CECSMH is to simplify the wiring harness in automobiles by multiplexing technology and to process various control operations by a central processing unit. The system must also be practical, inclusive of all needed signals, flexible in application to any type of vehicle, compact, inexpensive in mass production, reliable, durable in the automotive environment, and easy to service. The system as designed consists of one central processing unit (CPU), several local control units (LCU), and a multiplexing signal harness. A total of 32 LCU's can be installed in the system and each LCU is connected to eight electric devices (electric loads and/or switches and sensors), so that this system can conceivably control up to 256 electric devices. LCU's are located according to the arrangement of electric devices on a car model. The multiplexing signal harness consists of a clock signal line (CL line) and a control signal line (SG line). System operation is described in logical function proceeding from electric device status detection to input to driver if necessary via warning or troubleshooting sequence. Various semiconductors for the system were newly developed, including a local processor for the LCU's, power transistor, buffer amplifier, local processor for CPU, line driver/receiver, and surge absorber. A rotary-engined Mazda RX-4 was modified to incorporate the CECSMH, comprising one CPU and 10 LCU's. Various operation tests were made on the test car for confirmation of every function. Time division multiplex transmission gave no functional problem, and no erroneous operation was caused by electric noise of various devices of the car such as ignition system, horn, and motor. Electromagnetic interference of the miltiplexing signal to other car-mounted electronic equipment was not observed, and interference between the multiplexing system and the car-mounted transceiver was not observed when proper grounding was used. Signal waveform remained uninfluenced and all functions worked correctly even within a strong electromagnetic field. Reliability of the new semiconductors was also demonstrated in a test consisting of 13 items, including high temperature operation and life testing. Additional reliability testing and cost-efficiency gained through mass production are premised in adoption of the CECSMH for mass-produced automobiles in the future.

by M. Watanabe; S. Sumida; A. Ueda; H. Ito; M. Ishii; M. Nakayama
Toyo Kogyo Co., Ltd., Japan; Mitsubishi Electric Corp., Japan
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p23-8
1976
Conference held in London, 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 333

MULTIPLEX CONTROL SYSTEM FOR A MOTOR VEHICLE

A 16-channel multiplexing control system for a motor vehicle was conceived as a replacement for the hard wired cable harness and dashboard-mounted heavy duty switches which must carry the full load current found in a vehicle. In the multiplexing system the cable harness was replaced by a flat copper ring main carrying seven small signal tracks and one large power track for the lighting loads. The system transmitter and receivers were mounted directly on the ring main. Additional facilities can be monitored or controlled by simply connecting additional receivers onto the ring main. The heavy-duty control switches can be replaced by smaller ones. Not only can information be sent from the transmitter to the receiver but also back to the transmitter, providing a facility for load status display and remote data transmission. Main design criteria have been geared to compete with the standard hard wired system in reliability, immunity to electrical interference, and ease of installation. System components are monostable multivibrator, astable multivibrator, counters, clock, gating logic, transmission gates, displays, input facilities, and multiplexer. The system operates by input scan, displaying results if necessary, in a continuously renewed cycling mode. Use of comparators permits the checking function of the multiplex control system. Measures adopted to prevent system malfunction by interference include: use of logic elements with immunity to noise and requiring no regulated power supply; signal levels do not exceed logic power supply; data pulse is narrow, occurring only when the clock is in the low state; data have to be the same for two scans before the receiver will act on it; receiver counts clock pulses in each scan, rejecting data if the number falls below or exceeds a preselected number; lead actuation occurs only in the receiver dead period; load status detector is arranged to give fault indication if the load fails; and each control signal track on the ring main is screened by a grounding track on either side to minimize pick-up. Mechanical packaging consists of rigid copper-clad fiberglass boards overclad with a flexible circuit board which gives a package of high density. Receivers are coded by punching holes in a flexible tab connected to preset inputs of the receiver counters, and ring main connections on transmitter and receivers are etched on the rigid circuit boards. Units are housed in molded nylon boxes which push onto a connector, providing a self-cleaning facility for the contacts. As a future development it is proposed to house all external conditioning components in the same hybrid package, with physical size determined by dimensions and configuration of the vehicle and its assemblies. The control system as installed in a test vehicle (a Volkswagen Caravette) has been used for 2.5 years over 16,000 miles. Reliability, ease

installation and modification, unique display capabilities, id diagnostic functions have been demonstrated.

/ J. Seagrave; B. M. Huk
T Cannon (GB) Ltd., England; ITT Components Group urope, United Kingdom
ibl: HS-019 325, Automobile Electronics. International onference, London?, 1976 p29-32
76; 2refs
vailability: In HS-019 325

S-019 334

NOVEL AUTOMOTIVE DIAGNOSTIC SYSTEM

new diagnostic procedure for dynamic diagnosis of automo-ve problems, developed as an economical alternative to diag-ostic computers, enables investigation of engine performance id isolation of faults by measuring some integral quantities: ffective engine power, full-power exhaust gas carbon monox-e content, cylinder power balance, and ignition reserve. The asic component of the dynamic diagnostic system is a novel, w-cost inertia chassis dynamometer which is in series oduction. It works by analog electronic signal processing, id effective engine power is digitally displayed in kilowatts y the hand-held control unit. Additionally, this unit contains a witch for selecting measurement velocity; a display switch for ading alternatively engine speed, car velocity, road power, engine power, a control switch for the pneumatically erated lift bar; and a pen lift switch for an optional X/Y corder. Execution of a power measurement cycle proceeds om measurement of engine power via the wheels of the au-omobile by calculating it from acceleration and deceleration rotating masses. A correction factor is used to account for fficiency transfers from three power transmitting devices ransmission, differential, tire/roller), with selection for auto-atic or manual transmissions. Calculation of power on the ynamometer apparatus is performed by an analog processor, nctioning in precision differentiation and multiplication. Car-on monoxide concentration of exhaust gas can be measured / any conventional tester that is suited for working under full ower conditions for short time intervals, with the percentage valuated for position between or outside of two limiting alues. Cylinder power balance is checked by driving one ower measuring cycle per cutout cylinder and comparing in-vidual road or engine power decays. This measurement is erformed with any engine tester with selective cylinder cu-ut installation. Testing ignition reserve indicates whether in-fficient energy is stored in the ignition coil or if ignition ower is being dissipated by a parasitic secondary load con-ductance. For measurement of engine power the only connec-on necessary between car and dynamometer electronics is a agnetic clip-on trigger sensor for taking engine speed from e ignition cable of any cylinder. Checking cylinder balance id reserve requires connection of an engine tester to the coil rimary and car battery. The diagnostic method utilized is emonstrated as an interesting and economical alternative to mputerized automotive diagnostic equipment which is well apted to the needs of the ordinary automobile repair orkshop. Its advantages are low cost for investment and peration, no cost and no problems relating to software and ir model change, economy in working time, compatibility ith existing workshop equipment, and simple operation.

/ D. Pohl
obert Bosch GmbH, Stuttgart, West Germany
ibl: HS-019 325, Automobile Electronics. International onference, London?, 1976 p36-9
76; 1ref
vailability: In HS-019 325

HS-019 335

DEVELOPMENTS IN THE FIELD OF COMMERCIAL VEHICLE TRANSMISSION CONTROL

The transmission system of a conventional vehicle, consisting essentially of two components having performance characteristics which enable the vehicle to be started from rest under a variety of loads and driven at appropriate speeds over all road conditions, was analyzed. Components and functions required are: some form of coupling which will provide smooth transition in torque at the output shaft, smooth acceleration of the output shaft from rest and when moving, and a solid or near-solid drive once the full torque condition is established; and a multi-ratio coupling providing various steps of mechanical advantage and associated speed ratio. Some transmissions keep the two functions separate, while others perform both functions within one mechanical unit. Conventional combinations feature a torque converter and an epicyclic (or similar) gearbox, with the torque converter providing torque coupling and multiplication and the gearbox providing smooth transition in torque. Application of such apparatus in commercial vehicle transmission control presents problems in gear changing to allow for speed matching in gears (relating to gearbox life) and in fuel economy. The pattern selected for operation in heavy road vehicles is a system in which road speed is the determining parameter for gear selection. The relationship adopted is such that the vehicle idles in first gear with the fluid flywheel slipping; as engine speed is increased the flywheel progressively locks up and the vehicle accelerates; at predetermined road speeds, up changes occur. Should the vehicle encounter a hill, down changes occur at speeds somewhat lower than the corresponding up changes except when the driver removes his foot from the throttle pedal as when approaching a bus stop or a traffic signal. In this case the gear which is engaged at the time is retained, and the vehicle coasts in that gear until the speed has dropped to a lower value at which point a change directly into first gear occurs. With the change speeds chosen to suit the type of vehicle and the terrain on which it is to operate by relation to road speed, the commercial vehicle automatic transmission control arrangement provides good fuel economy and a minimum of gear changes so that gearbox life is maximized. Additional facilities available as options may include a switch to inhibit up changes in certain circumstances (hill climbing or hill descent braking) and a switch to enable change speeds to be raised by a preset factor (normally about 10%). An electronic control unit for the transmission of commercial vehicles has a relatively small total market, dictating a design suitable for small-scale production. One such design employs comparators as logic elements in an arrangement where an analog speed signal, derived from pulses generated in a reluctance pick up cooperating with a toothed wheel on the gearbox tail shaft, is used to determine the change points. One type of circuit package, a quad comparator, is used throughout to ease production. Current research on signal intermittency, interference, and clutch refinements is discussed with relation to the development of a viable commercial automatic transmission system, predicting the application of electronic control to solve many of the problems encountered.

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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p40-3
1976
Availability: In HS-019 325

HS-019 336

AUTOMATIC TRANSMISSION CONTROLLER USING A MICROPROCESSOR

An automatic transmission controller has been designed using a microprocessor to produce in effect a computer-controlled automatic gearbox. A prototype has been built using the Intel Co. 8008 microprocessor, and field trials are underway in heavy vehicles. The controller being tested is a plug-in replacement of conventional controllers, necessitating the use of relays already installed to perform control functions. This in effect defines the information available to the controller as well as the control signals it must provide. The data sets identified include driver commands, vehicle status, and control outputs. Driver commands are inputs to the controller from the driver cab; start, automatic, hold third, hold fourth, and reverse are provided by a conventional five-position switch in the form of a gear stick. A kick-down facility is a switch actuated by full depression of the accelerator pedal. Vehicle status information concerns road speed, air pressure, and gear currently engaged. Control outputs are gear select signals which are applied to the electropneumatic actuator, one signal for each gear considered, to the throttle dip valve to reduce fuel supply to the engine to promote smooth gear changes, and to the warning lamp to warn the driver when a malfunction is detected. The design philosophy adopted was to minimize the hardware complexity by relegating as many tasks as possible to software. The controller, as designed, utilizes the concept of a common bidirectional data base by which the microprocessor multiplexes information received from the vehicle and control signals sent to the actuator. The prototype built has four input ports and one output port, each capable of carrying eight bits of information. Upgrading of the controller is also relatively simple by simple connection to the common data base. The program used by the microprocessor controller is held in several read-only-memory packages, together with the values of road speed at which changes of gear must take place. Features afforded by this software version include road speed measurement, energizing gears, and road speed testing (such as before setting reverse gear). The resulting controller offers advantages over any other system in areas of cost, reliability, power consumption, ease of servicing, and flexibility. The upgrading facility of the microprocessor controller could provide several additional control functions for use in making large vehicles safer and easier to drive.

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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p44-6
1976
Conference held in London, 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 337

DEVELOPMENT TRENDS FOR BATTERY IGNITION SYSTEMS

Development trends for battery ignition systems are described with particular reference to applications to single-spark transistorized coil ignition systems. Functional requirements placed on new ignition systems include power stage (dependent on engine type, air/fuel ratio, compression ratio, EGR-ratio, and spark plug design), spark timing (for determination of the ignition point in relation to engine behavior, durability, and safety tolerances as functions of accuracy, complexity, and control), high-voltage distribution (minimum power loss and maximum retention of pulse shape), and spark plugs (matched to electrical output data of the power unit, selected spark gap, and engine voltage requirement). New requirements arise through the use of electronic components because of voltage transient loads and engine compartment temperatures. Various existing ignition systems are described to illustrate developmental stages and refinements. Breakerless TCI (transistorized coil ignition) systems utilize single-pole or multi-pole inductive pick-ups, on/off oscillators, infra-red light gates, or Hall sensors, and select the ignition point by mechanical components as a function of engine speed and load. Fully electronic systems have a computer coil control unit to determine respective optimum ignition from arbitrary parameters and to generate a trigger pulse for a power stage. Hybrid systems have some functions still provided by mechanical distributor, with basic timing corrected as a function of computed additional inputs. The high-voltage distribution system is conventional, with a mechanical distributor, but in a simpler, more economic design. In the U.S., the breakerless TCI-system has become the standard, and the introduction of hybrid systems is in the offing. In Europe, the breaker-type coil ignition system is still predominant, but also being increasingly replaced by breakerless systems. These refinements represent generational progress with regard to power, accuracy, and maintenance. Other generations of ignition systems, such as hybrid systems and computer coil ignition systems, allow new possibilities for the engine designer and are expected to be increasingly attractive as new requirements are placed on ignition systems. The direction of engine development to meet new requirements regarding emission regulation, fuel economy, and new fuels is seen as the major influence for further development and adoption of new ignition systems.

by H. Manger
Robert Bosch GmbH, Federal Republic of Germany
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p47-50
1976; 7refs
Availability: In HS-019 325

HS-019 338

SELF-ADAPTIVE IGNITION TIMING SYSTEM

The feasibility of a self-adaptive ignition timing system was investigated on the cylinder of a four-cylinder 2000cc overhead cam engine. Instrumentation for cyclic control included a pressure transducer mounted into the rear of cylinder four combustion chamber such that the diaphragm is flush with the chamber wall; and a crank angle measurement made from a slotted disc mounted on the front of the crank shaft chopping an infrared beam. The cyclic measurement of work done by the cylinder was obtained by a summation which is incremented at every crank angle degree, representing the area under the thermodynamic pressure volume curve. The accuracy of the work done/cycle measurement is dependent on the accuracy with which cylinder four piston position is measured. The effect of the retarded error which may be inherent in the initial setting by the manufacturer is self-cancelling, and the controller only seeks the position of the peak value of work done/cycle from the angle of the peak. Typical results for work done/cycle versus timing show that the work done/cycle increases, then decreases with advanced timing angles, exhibiting an extremum while peak pressure increases from a lower limit to an upper one. Both measurements exhibit considerable variations at any given timing angle which are a direct result

of cycle-by-cycle combustion variations rather than measurement errors. The work done/cycle variations increase on either side of the extremum and the peak pressure variations remain constant between the limits. Numerical results indicate that the mean work done/cycle curve is symmetrical at full load and assymetrical at part and no load conditions, reflecting the effects of dissociation, heat loss, finite flame speed, turbulence, and other factors. The form of controller considered is speed dependent, realizing the best form of transient response by relating it to a number of engine cycles rather than time. The controller is realized by a simple recursive relationship using a function of the gradient estimate made between consecutive firing cycles as the correction factor. Two classes of controller are possible: fixed step and variable step. They vary in terms of step response, steady state performance, and stability, with the fixed step controller unconditionally stable. The variable step controller is only conditionally stable as determined by the relationship of noise to perturbation length and curvature of hill. The performance of the controller engine loop was simulated and tested, typical results showing a transient response of about 12 cylinder firing cycles and a steady state loss in work don/cycle of about 0.4%. Although this performance is better than has been achieved by other methods, the need for a step limit restricts the transient response. The controllers were realized by analog circuitry and tested in engines. These test results agree significantly with those of the simulated model, but practical transient response is faster due to engine dynamics. Results of the investigation show that it is possible to achieve a practical transient response of six cylinder firing cycles for a steady state loss in work done of less than 1%. It is concluded that control of sprak timing of individual cylinders of an internal combustion engine by seeking the maximum value of the work done/cycle for those cylinders is valid.

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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p51-5
1976; 6refs
Availability: In HS-019 325

HS-019 339

ELECTRONIC IGNITION - A VEHICLE MANUFACTURER'S DEVELOPMENT AND OPERATING EXPERIENCE

Typical problems, failure modes, and causal factors encountered during the development phases and initial application of electronic ignition components to the automotive environment are described, defining the durability and reliability expectations of the manufacturer. Requirements in terms of performance are given as: increase in secondary voltages and energies to permit satisfactory firing of eroded spark-plug electrodes, and elimination of the contract breaker or improvement so that it handles a reduced current to minimize contact erosion. Three major electronic systems were considered on the factors of design concept, operating experiences, and promotability. The transistor-assisted contacts (TAC) system (1967) features low cost, high primary current switching, higher secondary voltages, and extended service intervals. Operating experiences showed an abundance of premature failures due to transients, usually attributed to inability to survive voltages occurring in a simulated engine compartment. Introduction of zener diodes and better wearing rubbing block material improved the TAC, achieving increased secondary voltages and a service interval of 25,000 km. However, the contact breaker problems were not eliminated, and any failure of the TAC module was incremental to the conventional system. TAC was not considered cost-effective for volume production, and newly aroused interest (1970) in the potential advantages of capacitive discharge systems (CD) caused a lack of promotion. The CD system comprises a breakerless distributor incorporating a vane-switched oscillator trigger, crankshaft trigger, or LED trigger; a capacitor; a 12-volt invertor for generatinga 380-volt capacitor charge; and trigger control firing system. Initial design of the CD system with short spark duration had severe performance limitations. Although performance was improved by electronic components, reliability shortcomings of a mechanical nature (fracture of inverter pot core, corrosion, tracking, and connector failure) cancelled out electronic reliability. Although, like the TAC, the CD system was not considered promotable, information from their investigations permitted better definition of both electrical and mechanical requirements in engineering specification. Investigation into breakerless ignition systems commenced in 1972. This system eliminates the contact breaker and utilizes a trigger to switch an amplifier module producingprimary current to the ignition coil. The system in test and use has demonstrated consistent firing, low maintenance, and higher secondary energies to permit lean burn conditions. Minor problems include low noise immunity and connection problems. The distributor has been increasingly featured on European vehicles and is becoming a standard in U.S. mass production and use. The system is considered to have met performance requirements relating to temperature, polarity, reliability, transients, durability, and use. From these experiences promotion and marketabiity factors are suggested for assessment: marketing pressures, costs, revenue loss from extended maintenance, and improvements in fuel economy, emission, and performance.

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Ford Motor Co., Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p56-60
1976
Availability: In HS-019 325

HS-019 340

ELECTRONIC FUEL INJECTION: INTRODUCTION IN THE U.S.A.

Introduction of electronic fuel injection in U.S. passenger cars during model year 1975 is described in terms of the current system produced by Bendix as well as their experience in starting up a high-volume automotive electronics production operation. First installations represented two extremes in the General Motors product line: large luxury sedans (Cadillacs) and subcompacts (Cosworth-Vega). The basic function of the Bendix fuel injection system is to precisely compute and deliver to the engine (in response to selected sensed engine operating parameters) amounts of fuel such that emissions level and fuel economy requirements are met and good driveability and performance are achieved. The system is presently configured as a low-pressure, two-group, pulse-timed intake manifold injection system, which meters fuel to individual cylinders by injecting it in precise bits (once per engine cycle) in the vicinity of each individual cylinder intake valve. Fuel delivery is controlled by individual, electrically actuated, solenoid injection valves. The quantities delivered (a function of

injection timing and pulse duration) are controlled by the electronic control unit (ECU), which precisely computes fuel requirements on the basis of three engine parameter measurements: intake-manifold pressure, engine speed, and air temperature. From these parameters and known engine physical and operating characteristics, air flow is calculated. Other parameters measured are engine phasing, engine operating temperature, and air throttle valve position. Major system elements include ECU, sensors, and injectors. Manufacture of the fuel injectin system involved consideration of stringent performance, accuracy, and reliability constraints. Quality control was assured by continuous monitoring of material and finished goods performance, with daily engineering specification testing to obtain statistical data on production trends and to ensure early detection of material or processing problems. Field experience with the Bendix systems has demonstrated some problems with the ECU (process control and quality control of vendor supplied components), pressure sensors (epoxy fastening and aneroid capsule leakage), fuel systems (leakage), and system fault diagnosis (lack of field experience and specific training). Future development of such systems will depend on high volume manufacturing processes to effect better cost-efficiency, evolution of design into lower cost fuel management systems (such as single-point improved fuel atomization), and improvements in electronics utilization.

by J. G. Rivard
Bendix Corp., U.S.A.
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p61-4
1976
Availability: In HS-019 325

HS-019 341

DIGITAL TECHNIQUES FOR THE CONTROL OF FUEL AND REDUCTION OF EXHAUST EMISSIONS

Digital techniques for the control of fuel and reduction of exhaust emissions are described, and operation of such a digital control unit is illustrated from records of actual vehicle applications experience including comparision with an analog control unit programmed for same vehicle application. Electronic fuel injection systems deliver fuel to injectors at a pressure controlled by a regulating valve, with pressure held constant or modulated as a function of manifold depression. INjectors are fundamentally electromagnetic on/off valves, the quantity of fuel they deliver being determined by the time they are held open. The open period is scheduled by an electronic control unit which is itself governed by input signals such as engine load, speed, and water and air temperatures. Revision of the control unit function for such systems by use of a digital memory which may be employed with any form of engine load sensing tranducer is described. The digital memory stores fuel requirements programmed for both engine load and speed, and allows computation of optimum fueling for a far greater multiplicity of speed and load conditions than could be obtained economically with analog techniques. The operation of such a digital control unit is described with reference to a manifold pressure system and its application to a 12-cylinder engine, incorporating manifold pressure and engine speed measurements, conversion of engine period into digital signal, memory handling, interpolation, and fuel consumption commands. The objective of vehicle applications has been to meet specific emission regulations with an adequate safety margin while maintaining good driveability and possibly improving fuel economy. In comparision with an analog system, the digital system provided notable improvement in driveability and emissions reduction.

by M. Williams; G. F. Beasley
Lucas Electrical Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p65-8
1976
Availability: In HS-019 325

HS-019 342

APPLICATION OF CLOSED LOOP CONTROL TO FUEL METERING

The structure of the fixed plant of closed loop control for use in adjusting and maintaining air/fuel ratio in vehicles accurately independent of wear and tolerances of the engine and the fuel metering system is studied to indicate a practical compromise between emissions and engine performance. Components comprising the closed loop include the lambda sensor, controller, fuel metering system, and engine. The time response of the closed loop consists of time response of the controller, response of fuel metering system, delay for transport of mixture from metering system to intake valves of engine, transport of mixture through engine, delay for transport of exhaust from outlet valve to lambda sensor, and time response of lambda sensor. The fuel metering system in most cases can be approximated by a first-order time delay with the frequency response. Transport delay repreSenting movement of the mixture from the metering system to the intake valve of the engine depends on the applied metering system (carburetor, single-point injection, or individual port injection). The transport of the mixture through the engine is a function of engine speed. The movement of the exhaust from the outlet valve to the lambda sensor is also represented by a transport delay, depending on engine speed, engine load, and location of the sensor. The time response of the lambda sensor can be approximated by a first-order time delay with high gain. Variation of parameters representing movement of the mixture through the engine and describing the exhaust gas transport delay between outlet valve and lambda sensor depend on the engine operating point. The frequency response of the controller selected must include an integral portion to assure full compensation of any disturbances to the fixed plant. Due to the nonlinear on/off type characteristic of the lambda sensor, the closed loop maintains an oscillation even under steady-state conditions, with frequency of oscillation determined by phase shift of the controller with integral response and transport delay. A self-adaptive controller with a variable time constant is described which can respond fast enough to compensate for disturbances and slow enough to keep amplitude of oscillations small, in particular at low engine speed. Initialization of the closed loop control is accomplished by operating open loop at lower sensor temperatures with the integral controller output clamped at a selected preset level. After the controller is initialized, the operation of the closed loop can be monitored on a continuous basis. Reference adjustment of the lambda sensor is described to decrease the frequency of the closed loop oscillation to cause an increase in amplitude according to preregistered input to the system. Closed loop control compensates automatically for: tolerances, wear, and drift of the engine and the fuel metering system; changes in fuel composition; and variation of atmospheric pressure due to different elevations. The lambda sensor control device enables better adherence to tighter emission standards for motor vehi-

cles by more accurate adjustment of air/fuel ratio of the engines.

by H. Eisele; W. Wessel
Robert Bosch GmbH, Stuttgart, West Germany
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p69-74
1976; 4refs
Availability: In HS-019 325

HS-019 343

INTEGRATED CIRCUIT INSTRUMENTATION FOR VEHICLES

The development and use of integrated circuit (IC) instrumentation in vehicles are discussed in relation to tachometers, speedometers, and seat-belt interlocks. The need to reduce complexity of manufacture and thus costs and to improve accuracy and general specification of instrumentation have led to custom designed IC combined with thick film circuits to reduce piece parts and improve reliability in instrumentation. With the dedicated design it is possible to incorporate the necessary pulse shaping and processing to deal with a range of input transducers, tailor precisely amplifying, timing, threshold, and other parameters, and to build output stages on the samc chip with enough power to optimally drive actuators and indicating devices. The IC tachometer was initially designed for sport boats, but applications in low-cost automobiles using ignition current pick-ups replaced several discrete component tachometers and in high-sensitivity diesel vehicles working from low output inductive pick-ups and alternating current generators. The necessary versatility was designed into the circuit from the outset to enable signals from the variety of existing transducers to be processed without the use of external signal conditioning of amplifying, keeping the circuit design as simple as possible consistent with adequate performance. The user of the IC tachometer has all the details of his various existing or planned input transducers, giving a variety of signals to be catered for, and the output devices can be driven at the optimum driving conditions, but such designs are based on general conditions and the versatility needed to gain the widest market and necessarily compromise lowest cost criteria. The IC commercial vehicle speedometer was designed to meet a demand for a remote speedometer in vehicles. Although a discrete component electronic speedometer was available for this use, a custom IC design incorporating all the necessary drive transistors and division circuits was developed because of the reduction in number of piece parts and greatly reduced test and calibration times. A seat-belt interlock system using IC is also described, designed to operate on the seat belts and the starting circuit of private cars to insure that the engine can only be started if the car is occupied or when the occupants of any front seat have been belted properly. The IC is used to perform the logic function, which would otherwise require many discrete transistors, and to drive an external transistor to inhibit the starter relay, with emphasis on reliability. The use of thick film substrates is described as a producion process for decreasing assembly costs, improving reliability, and allowing removal of a potentiometer which was sensitive to environmental conditions. Cost efficiency of IC instrumentation has become a major factor in private car applications, with a trend toward combination of functions into fewer and finally one package: the centeral processor. Special consideration of environmental influences (temperature, voltage, vibration, and humidity) in vehicle instrumentation give IC instrumentation technology added support.

by A. P. Goss
Smiths Industries Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p75-8
1976
Availability: In HS-019 325

HS-019 344

D.C. 0DIRECT CURRENT0 ELECTROLUMINESCENCE FOR AUTOMOBILE INSTRUMENTS.

Available methods of display used for instrumentation in motor vehicles are reviewed with emphasis on the advantages of direct current electroluminescence. Methods including tungsten filaments, light-emitting diodes, cathode ray tubes, gas discharge (plasma panels), alternating current or direct current electroluminescence, liquid crystals, electrochromic liquid or solid, and electrophoresis were considered in the context of parameters of overall system cost, visual appeal, reliability, life, and legibility covering all brightness and contrast aspects. The display preferred must be capable of being manufactured on a large-scale basis with a reasonable level of tooling and a minimumof assembly labor, it must be compatible with available integrated circuits, and it should operate within reasonable voltage and power limitations. The ability to multiplex is a critical factor for selection. Direct current electroluminescence was selected for development work as the favored display method. It has the particular advantage of emitting light, hence requiring no other means of illumination. The overall visual appeal, together with package cost advantages, have favored its technology at the present time. The preferred phosphor is normally zinc sulfide, which emits a predominantly yellow light, with other colors being obtained by using optical filters. The advantage of direct current electroluminescence for vehicle display applications is that under normal and low ambient lighting the display has considerable visible appeal with a reasonably wide range of colors. Disadvantages are associated with the available brightness and contrast ratio under extreme sunlight conditions and the expected life under high brightness conditions. Direct current electroluminescence displays are constructed of polycrystalline copper and manganese coped zinc sulfide power phosphors, fabricated on transparent conductively coated glass substrate which are photolithographically etched to provide delineation of the required light emission pattern and electrical lead-ins, and hermetically sealed in a robust flat pack configuration. The devices operate with high visual efficiency, giving excellent legibility and an arresting appearance. The emission is physiologically restful for continuous observation, while contrasting sharply with unselected areas of the display and the surroundings. The display brightness is continuously variable either manually or by remote photocell control to suit prevailing ambient conditions, and a wide range of formats is possible. The simplicity of construction and processing are suited to large-scale production, while flexibility in design allows economic manufacture of small quantities for prototype assessment. Multiplex integration in electronic circuitry is also feasible with direct current electroluminenscence, further assuring reliability and low expense. It is concluded that with the present state of available

technology, direct current electroluminescent displays will be available for vehicles in the early 1980's.

by B. Shepherd; R. N. Thomas; P. J. Smith
Smiths Industries Ltd., United Kingdom; Phosphor Products Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p79-83
1976; 1ref
Availability: In HS-019 325

HS-019 345

THE DESIGN OF AN ANTI-GLARE HEADLAMP SYSTEM

An anti-glare headlamp system has been designed as an attempt to avoid the glare effect of a headlamp by detecting the position of an opposing headlamp and cutting off the beam of the glare source in that direction, using an optical shutter. The newly developed system comprises a source, optical system, a segmentated cell capable of controlled light absorption, and a radiation detection system segmented in the same fashion as the light-absorbing cell. The technique involves the detection of the spatial location of a glare source and the using of this information to activate the corresponding area of the light-abosrbing cell. The region of cell selected is that which obliterates the light from the glare source which passes in the direction of the observer. Thus, the whole forward field of the first source could be illuminated with the exception of the elemental solid angle subtended by the region surrounding the glare source. The result would be that if two vehicles, equipped with apparatus designed on this principle, were in the meeting beam situation, almost all of the field between the two would be illuminated, but neither driver would cause nor suffer disability glare. In development, two detectors (one active and one passive) were used for locating the glare source, using a self-scanned linear array or a linear array of photodiodes, respectively. Two types of light-absorbing cells were studied for inclusion in the system, dichroic liquid cells and nematic liquid crystal cells. Two prototype projection systems were constructed and tested. System 1, comprised of photodiodes, processing electronics for 12 channels, a 12-element linear array dichroic liquid cell, invertor, and optical components, showed encouraging results in tracking a simulated glare source and maintaining an observer in a field of relatively low illuminance. The system was disadvantageous in that a considerable proportion of light is absorbed by the cell even when the cell has its maximum transparency, the lifetime of the cell is too short to be of commercial value, and the high voltage requirement complicates the design. System 2, comprised of 32 element self-scanning array of photodiodes, processing electronics for 24 channels, a 24 element twisted nematic liquid crystal cell, and optical components, demonstrated capability in tracking, but the cell was not capable of sustained operation at the high power levels involved. The possibilities of an electro-optically controlled headlamp beam were demonstrated in the development and tests. Use of self-scanning arrays is recommended as the basis of integrated circuit manufacture, since scanning and processing circuitry could be produced on one chip.

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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p84-7
1976; 5refs
Availability: In HS-019 325

HS-019 346

CONTROL OF DIPPED BEAM HEADLAMP INTENSITY FROM URBAN STREET LIGHTING

Development work in control of dipped beam headlamp intensity from urban street lighting is described leading from the concept of a simple manual system to a fully automatic headlamp controller where beam intensity is controlled as a function of street-lighting quality. A unique feature of the final system developed is its ability to differentiate between light from street lighting and light from other sources (vehicle headlights or daylight). Thus headlamp intensity is only reduced under conditions where it may be desirable to operate headlights at full intensity because of poor visibility. Design of the controller was based on a comprehensive road lighting survey to investigate the variance in lighting quality available, and to assess the ability of a simple transducer and processing technique to extract a parameter representative of the adequacy of a lighting installation. For the survey two test vehicles were equipped with several transducers for observing street lighting. In particular the 100 Hz component of light and direct current light components were monitored. Transducers were adjustable so that the effects of different viewing angles could be studied. A vehicle-mounted magnetic tape recorder was employed to record data from transducers while the vehicle was in motion, and facilities for interface with a paper chart allowed displays of data in the time domain to be generated either directly from transducers or on replay from the recorder. In conjunction with analysis of analog data, a computer analysis allowed results to be displayed graphically in the form of lighting intensity distributions together with frequency distributions showing frequency of occurrence of both maximum and minimum intensities. Subjective assessments of lighting requirements were made and matched with the data analysis, indicating a balanced availability of 7 volts (approximately 80 candelas in the straight ahead direction) during maximum dimmed condition gives an acceptable glare level with sufficient intensity to provide presence information. Selection of dimming and its extent is suggested along with lighting quality criteria measurements according to traffic conditions and lighting conditions. Essential conditions described for a headlamp control system include gradual reduction in headlamp lighting intensity, faster response to full intensity condition, and lack of response to isolated unlit lamps. A prototype headlamp controller is described, utilizing silicon photodiode as the photodevice on the grounds of sensitivity, stability, response at 100 Hz, spectral response, and economy. Selectivity of the system is governed by use of a transducer designed to be responsive only to the 100 Hz component present in street lighting due to mains energization. The road lighting survey and design of signal processing circuitry have demonstrated the feasibility of producing an electrical signal giving a measure of street lighting quality, so that vehicle headlamp intensity may be controlled responsively.

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Joseph Lucas Ltd., Group Res. Centre, United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p88-91
1976; 4refs
Conference held 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 347

TEMPOMAT

An automatic cruise control system, TEMPOMAT, has been developed to relieve vehicle drivers from the many corrections of gas pedal position which are necessary in order to obtain a constant driving speed in spite of different gradients, road, and wind conditions. TEMPOMAT enables cruise control while allowing the driver to relax physically and psychologically. As the automatic control reacts earlier and with more sensitivity than the driver, a more progressive and more economic drive is obtained. The entire system is operated by a single lever. Pushing this control lever to the direction which corresponds to the desired mode switches the TEMPOMAT on or off or commands to resume a speed driven previously. When the speed must be increased or decreased, the lever is pushed to the corresponding direction until the vehicle is travelling at the new speed. TEMPOMAT stores the selected speed at the moment it is switched on, constantly comparing this speed with effective vehicle speed, compensating deviation by a corresponding adjustment of the gas pedal. The driver can influence driving speed upward by depressing the gas pedal to accelerate; when he relieves the gas pedal the TEMPOMAT controls the vehicle again to maintain the previously selected speed. On braking, declutching, or when the speed falls below 20% of the selected speed (e.g., when gradient encountered cannot be negotiated with the selected gear), and when speed is less than 35 km/h, TEMPOMAT automatically cuts out. Control lever regain is permitted by pushing again on the control level. All TEMPOMAT modules are designed to permit installation in retrofitting passenger cars. A Bowden cable is used for connecting the output element of the system with the gas pedal linkage in order to guarantee the highest freedom in actuator installation, without interrupting the mechanical connection between gas pedal and butterfly valve. Subassemblies of the system include frequency generator, electronic control, actuator, and control module. The speed sensor is a 12-pole permanent magnet and a ring coil serving as a frequency generator, designed for installation in a two-part speedometer drive cable. When installed in production it can be combined with the speedometer. Design variants indicated as needed during development testing include erasure of memorized speed signal when the vehicle stops, limitation of acceleration during the first phase of operation, a manual acceleration of the vehicle to desired speed. It is concluded that both economy and safety may be aided by use of the TEMPOMAT system.

by L. Heimbach; A. Mann
VDO Adolf Schindling AG, Res. and Devel. Centre, Federal Republic of Germany
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p92-5
1976
Availability: In HS-019 325

HS-019 348

AUTOMATIC SPEED CONTROL SYSTEM FOR AUTOMOBILES

A system for automatic speed control for automobiles is described to meet the requirement for drivers to observe the speed of their vehicles and to adjust speed depending on road conditions. A set of easily operated, mutual release, latching type illuminated push buttons are provided, on or just below the car dashboard signifying 10, 20, 30, 40, 50, 60, and 70 mph. When the vehicle is moving below the selected speed the automatic system has no effect, and control of the accelerator pedal is as in a conventional vehicle. When the vehicle reaches the selected speed, an upward force is automatically applied to the accelerator pedal, opposing the downward force of the driver's foot. The accelerator pedal becomes precisely positioned to maintain the selected speed. If the foot is removed from the pedal, the vehicle will reduce speed in the normal way. Applications of use of the automatic speed control system include leaving a high speed area and entering a speed restricted zone, elimination of the need for individual speed monitoring, elimination of discomfort and fatigue of the foot and ankle in trying to maintain constant speeds, and automatic selection of correct speed by electronic remote control signal transmitted from the roadway or roadside in speed-restrictive conditions such as fog or emergency. With design priority given to safety, the advantages of the system are in safety areas: the system cannot cause the vehicle to accelerate, it only limits maximum speed; failure of the system cannot result in forcing speed upwards; and the system has no degrading effect on the vehicle's performance or acceleration under selected speeds.

by R. L. Moody
United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p96-9
1976
Availability: In HS-019 325

HS-019 349

TIME COMPRESSED AURAL COMMUNICATION LINKS TO MOVING VEHICLES

The Road Information Transmitted Aurally (RITA) system to form an individual communication link with every driver on major highways is described. RITA consists of an inductive transmission loop (about one kilometer long), roadside equipment to drive the loop, and a receiver onboard the vehicle to pick up the message. Information presented may be constrained to a single highway, and two repeats of a 10-second message are available for each vehicle not exceeding 113 kph. Messages for transmission may be routed to each site from a control center, utilizing amplitude modulation of a carrier for transmission on different channels in different languages. Other advantages of RITA are the continued operation of the system in bad visibility conditions, the ability to give detailed information which may be updated rapidly, and opportunity of laying temporary loops in cases of emergency or temporary disruptions. It is also felt that drivers would be more responsive to spoken information presented within their own vehicles than to visual indicators. The RITA system could be included as part of a car radio installation. Information may be given as priority and nonpriority, with all priority messages relayed to the driver irrespective of the state of the system, whereas nonpriority messages could be muted if desired. The major disadvantages of the RITA system are associated with the cumbersome loops, which are subject to difficulties in installation and maintenance, vulnerability during road repair projects, and expensive to install. An approach to the problem of the long loops is suggested in time compression of messages, utilizing shorter loops; in this modified system the onboard equipment would catch the message transmitted in compressed form and replay it to the driver in its normal length form. Both magnetic and solid state systems were considered for these compression effects. Study results indicate that a solid state speech synthe-

sis approach to a short loop communication system was attractive from a transmission bandwidth point of view and onboard storage requirements. But the complexity of the signal processing requires more development before a suitable system can be demonstrated. Development of a mechanical system seems more practicable, but suffers the disadvantage of requiring large transmission bandwidth. Cost of the product remains the dominant criterion for development.

by D. B. Hodgson
Joseph Lucas Ltd., Group Res. Centre, United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p100-3
1976; 5refs
Availability: In HS-019 325

HS-019 350

RADIATING CABLE PERFORMANCE FOR USE WITH A DRIVER INFORMATION SYSTEM

The feasibility of radiating cables for the localized transmitting aerial for use with a driver information system has been studied with respect to signal decays and standing waves. The signal decays adjacent to the cable determine the minimum separation between neighboring message zones, and preliminary research results suggest that decays in the longitudinal and lateral planes are acceptable for most highway situations. Standing waves in the field adjacent to the cable were also considered since the signal variations can sometimes give levels of 20 dB below the mean. The effect can be alleviated, either at the cable termination or in the receiver, and the relative merits of these two techniques are discussed. Since the position of signal minima in the case of a loop receiving antenna is dependent on attitude of the loop, an aerial consisting of two parts with their magnetic axes arranged as horizontal and perpendicular to each other with outputs connected to the receiver input via electronic switches such that the receiver alternates between them at a rate higher than the maximum audio frequency is proposed. This solution marginally increases the cost of the vehicle unit, whereas the solution for varying the cable's termination impedance increases the cost of the roadside unit. The aerial diversity solution does not widen the spectrum of the radiated signal, however, as will be the case where the cable's termination impedance is oscillated. A communication system concept is proposed consisting of prerecorded verbal phrases covering most emergency situations and, on receipt of information concerning a road incident, a traffic controller would select an appropriate combination of phrases and route the complete message over land lines to a roadside unit. There it would be restored and used to modulate a low power transmitter which in conjunction with a suitable aerial would radiate a localized signal. A system refinement is for amenity information to be also prestored at roadside location and transmitted continuously (route directions, availability of car parks, availability of service areas). Emergency transmission would be given priority over amenity information or in-car entertainment material. Potential advantages of such a system include: more information than could be given on visual signs, with flexibility to cover all situations; overcomes problems associated with poor visibility; reduction of the driver's sense of isolation; invitation to the driver for cooperation rather than for obedience; public events, major incidents, and road repairs coverage by on-site units. Both single cable and radiating cable systems have been considered, with flexibility of the latter indicating its preference in applications envisioned. Feasibility of installation and use of such a system has been demonstrated, with longitudinal and lateral signal decays adjacent to the coaxial cable being acceptable for most highway situations.

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Transport and Road Res. Lab., United Kingdom; Standard Telecommunication Labs. Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p104-7
1976; 6refs
Availability: In HS-019 325

HS-019 351

IDENTITY TRANSPONDER SYSTEM FOR VEHICLE LOCATION

A system for location of vehicles following fixed routes using battery-powered identity transponders as route markers is described. If the transponders placed along the fixed route are interrogated by a coded signal from vehicles passing, the system can identify transponders as vehicles pass and hence establish the vehicle's position. The use of modulated reflection for information transfer features no steady state emission from the transponder, digital coding, number of bits limited only by the time that the transponder is within range of the interrogator, limitation by location of transponders in relation to number of interrogator units, use of cheap, mass-produced microwave components, and short bandwidth requirement for the interrogating signal. Elements of the system include the transponder, interrogator microwave unit and subcarrier amplifier, wide dynamic range detector, signal processor, and vehicle location display. The transponder consists of a diode connected to a horn aerial, to form a variable reflecting device, together with a coder to generate the appropriate drive waveforms. The microwave unit is based on a commercial Doppler intruder alarm, containing an oscillator and a barrier mixer diode. The subcarrier is amplified in a tuned amplifier with a bandwidth centered and then fed to the detector unit. The detector consists of active rectifier circuits, one of which is a positive peak rectifier with a short time constant and the other is a negative peak rectifier with a long time constant. The two outputs are added and a comparator determines the sign of the output. Signal processing is carried out in the interrogator (slight) and in the central computer. The system can detect that a vehicle is at, or has just passed, a fixed point where a transponder is located. It is characterized as a beacon marker scheme rather than an area navigation scheme. Advantages of the system include low interrogating power, sufficient range, efficient use of spectrum, and use of existing mass-produced microwave components. Drawbacks are that the transponder needs a battery or other supply to provide power and only one transponder may be interrogated at a time.

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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p108-11
1976; 3refs
Availability: In HS-019 325

HS-019 352

A SYSTEM FOR AUTOMATIC VEHICLE LOCATION

A system for automatic vehicle location is described based on the technology of area coverage by a network of low-frequen-

transmitters, radiating a pattern of phase-coherent ring rise to a set of hyperbolic grid lines covering the rea. The signals received at the vehicle are not on board to give a position, but only rendered suita- transmission over a standard radio-telephone link to ol center together with information regarding crew le status. At the center the signals from all vehicles ied and processed by a digital computer to give vehi- on and status in a form suitable for display to the The system consists of a radio positioning system, ceiver, control center equipment, system timing, hone, and display. The radio positioning system is measurement of distances from fixed transmitting usually comprising a group of stations. A mobile dentifies the source of each transmission and the lo- the receiver is determined by its measuring the time s between the arrivals of signals from various sta- ng either energy pulses or continuous waves. The ceiver puts out a signal which is connected into the ie amplifier of a standard radio-telephone. Signals ed at the vehicle on a short antenna and fed to a e converter, employing an audio-frequency amplifier This signal contains the position of the mobile as those differences between successive bursts from the positioning transmitters. Control center includes a base station receiver, decoder unit, and System timing is transmitted from the prime station transmitting stations, mobiles, and control center, mobile retransmitting one sequence of the transmis- ch group of mobiles requires a decoder, but those same group share a radio-telephone frequency and rs can share a computer so as to spread costs of the ocation information is converted by the computer rdinate geographical system for ease in display read- racy of the system in use has been acceptable. It is that the approach to vehicle location described a good compromise between the conflicting require- radio spectrum conservation, complexity, and cost, t forms the basis of area systems capable of serving mber of users in a simple, effective manner.

Deslandes; J. D. Last
vey Ltd.; Univ. Coll. of North Wales, United

019 325, Automobile Electronics. International
e, London?, 1976 p112-5
s
y: In HS-019 325

3

E-BY-WIRE VEHICLE CONTROL SYSTEM VERELY DISABLED DRIVERS

y-wire vehicle control system for use by severely dis- ers is described. Drive-by-wire is a system with no al link between the driver and his vehicle's controls, an electrical connection. The system concept is that operates a knob or joystick to generate an electrical nanding a required control action, and electrically servo systems then move the steering, throttle, or ordingly. Advantages in use of such a system by disabled drivers are that the force and movement or driver's input can be as small as desired and the iput unit can be designed to suit his particular disa- d can be positioned wherever is convenient for him. -by-wire concept evolved from the Transport and search Laboratory's interest and involvement in development of a test track which incorporated means for automatic car steering through a buried leader cable system, with headway control based on buried loop vehicle detectors. In the process of developing and testing vehicles with these capabilities, a declutching vehicle system was designed to allow drive-by-wire mode driving, using a potentiometer on the steering wheel as the position command for the front wheel loop for use in driver/vehicle interactions studies. The drive-by-wire system was implemented in a dual mode bus application and in a preliminary handicapped-driver vehicle. Both vehicles were track tested, revealing problems of reliability and ergonomics of the driver's input unit. Two vehicles were subsequently completely outfitted with drive-by-wire systems for more intensive testing. The reliability problem was approached by incorporating a two-channel control system, greatly decreasing the chance of poor outcome of a steering failure. Use of the two-channel control system depends on independence between channels, being able to detect a fault automatically, and switching out the failed channel rapidly while warning the driver to stop. These requirements may possibly be met by use of an electronic model channel to evaluate performance of the two operating channels. The drive-by-wire system as tested consisted of the driver's foot operated joystick control unit with three gauged potentiometers; three steering column feedback potentiometers driven by separate anti-backlash gears from a pinion on the column; two electric motors each with its own power amplifier to turn the column; and the failure monitor and channel switchout system. Separate batteries are used for each channel, each isolated from the vehicle battery and from each each other and charged by a direct current convertor with an individual output winding for each battery. Power amplifiers are a switching type using transistors and drive-printed armature permanent magnet motors. A test panel for analyzing fault conditions was installed near the driver, and the minor controls were moved closer to the driver to enable use when physically possible. A passive restraint system is recommended to allow greatest independence of the disabled person in using the vehicle. Handicapped and nonhandicapped drivers using the vehicle under test track conditions were approving of the ease of operation and independence gained. It is concluded that improvements in reliability, ergonomics, and maneuverability in real traffic are necessary stages in further development of drive-by-wire vehicles.

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Transport and Road Res. Lab., Crowthorne, United Kingdom; Univ. of Reading, United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p116-9
1976; 4refs
Availability: In HS-019 325

HS-019 354

AN AUTOMATIC HEADWAY CONTROL SYSTEM BASED ON THE USE OF A MICROWAVE TELEMETRY LINK

The microwave telemetry links pass digital data between vehicles, with the need for cooperation between vehicles offset by the potential for complete automation of driving a vehicle on a suitably instrumented highway. In essence the longitudinal position of the vehicle is measured with respect to a datum in the road and transmitted over the link, together with lane number, acceleration, and other data, to all other vehicles within a given range. Any similarly equipped vehicle receiving these signals can discard those emanating from other lanes and

by examining position differences derived from vehicles in its own lane can determine headway to the nearest vehicle. Interest may also be concentrated on signals from an adjacent lane to examine the traffic pattern there and, if a suitable gap exists, action can be taken to effect a lane change. The microwave links could also be used to receive messages from simple roadside transmitters, giving the police a means of controlling traffic speed. Two vehicles were equipped with a microwave telemetry link automatic headway control system and tested in functions of position measurement, transmitted signal, acceleration, emergency mode, lane changing, sum checking, and mutual interference. Hardware included in the system included lateral guidance pick-up coils, steering actuator, wheel transducer, throttle/brake actuators, digital computer, signal processor, accelerometer, and road marker detector. Some required operations were accomplished so quickly that use of the digital computer could not be included, so special circuits were built for processes such as data word encoding/decoding, evaluation of the transmission-time algorithm, and sorting received signals according to selection. Once data have been extracted, the flexibility of the computer is invaluable for changing parameters associated with logical decisions, filtering data, calculating demanded velocity for own vehicles, and logging trials results. An important task is smoothing headway data and associated calculation of relative velocity. A simulator was also built to test the equipment in the laboratory, as a modified version of equipment fitted to a vehicle with major changes in computer software. Relevant data for up to 24 vehicles traveling on a three-lane highway were generated by the simulator program. The data were suitably encoded, fed to the microwave link, and transmitted via waveguide and an attenuator to the receiver of the equipment under test. A separate waveguide connection was also made from the transmitter of the real system to the simulator's receiver, and additional cross connections were provided so that each receiver would pick up the signal from its own transmitter as would occur in practice. Positions of the vehicles in real time was observed in graphical form on a display. The simulation system was inadequate in three areas of performance: propagation problems are avoided, vehicle dynamic response is simulated, and environmental factors (such as vibration) are absent. Track trials were incomplete due to funding problems, but automatic headway control was demonstrated successfully at short following distances and nothing was discovered to suggest that the system used is impractical or could not form a basis for an automated highway transport system in the future.

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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p120-3
1976; 1ref
Availability: In HS-019 325

HS-019 355

HARMONIC AND TWO-FREQUENCY RADARS FOR VEHICLE HEADWAY APPLICATIONS

A program designed to evaluate two approaches to vehicle-mounted radar systems for vehicle headway applications and to establish the principal limitations and potential performance capability of passive transponders is described. Radar approaches studied include: a harmonic radar which radiates a frequency which the transponder generates and retransmits and an alternative of radiating two frequencies with the radar receiver designed to detect one or more of the resulting m lation products. The evaluation included measurements us laboratory scale prototype radar which can simulate both monic and two frequency radar systems using nonlinear transponders. Properties and performance of such radar described with reference to harmonic radars, since alth two frequency radars have minor advantages in simultan measurement of range and velocity, it is at the expense more complex receiver designed to receive more than modulation product. Applications are envisioned from a ing aid which could tolerate failed detections and false al to a fully automatic system which would electronically co and warn of headway conditions. The harmonic radar sy designed and tested features a passive transponder consi of an antenna terminated in a diode which generates the monic return at 18.5 GHz. The process also doubles frequency sweep of the harmonic signal, which in turn do the range resolution capability of the radar. A small para reflector was used with the diode mount located at its f enabling the same antenna apertures to be used both for r tion and retransmission of the harmonic signal. The ex mental radar also employs a similar diode to genera frequency doubled version of the transmitted waveform w the radar which is then used as a local oscillator and m with the incoming signal to produce a difference frequ signal as with conventional frequency modulation techniques. Harmonic radar offers a unique way of rem clutter returns and detecting only wanted targets, but all targets must be fitted with passive transponders. Main li tions of this form of radar include the restricted maxi range and the need for higher transmitting powers than responding primary radars. Difficult problems of range are also present, especially in accurate measuremer velocity of targets. Filtration problems include the nee adequate suppression of harmonics radiated from the transmitter and of primary returns from the normal t mitting frequency entering the microwave front end of the monic receiver where they generate harmonics in the diode. While such problems can be lessened by incorpor of suitable filters and isolators in the transmitting and re ing microwave assemblies, such additions complicate make the apparatus more expensive. It is concluded tha vehicle-mounted applications harmonic and two-frequ radars can overcome several problems associated with pri radar: clutter returns, accuracy for range and velocity surements, precisely defined coverage range, and reducti interference from other radars. The use of any form of for vehicle headway control appears to be far from the of practical implementation since tolerance for practical s aspects must be closer than those observed in test confi tions.

by D. E. N. Davies; H. Makridis; C. D. McEwen
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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p124-7
1976; 2refs
Availability: In HS-019 325

HS-019 356

EVALUATION OF A Q-BAND AUTOMOTIVE PRIMARY RADAR 0FOR AUTOMATIC HEADWAY CONTROL0

A Q-band (1 cm wavelength) frequency modulated continuous wave (FMCW) radar of the primary (noncooperative), homodyne type is described and evaluated for use in fully automatic headway control systems for highway vehicles. The objective of the evaluation was to obtain a fundamental understanding of the problems associated with measurement of target range and relative velocity using a vehicle-borne primary radar, including signal processing and demodulation techniques. The FMCW radar system tested had a modulation period of 20 ms and a frequency sweep of 200 MHz, giving a theoretical range resolution of 0.375 m and a relative velocity resolution of 0.2 m/s. The antenna had a beam pattern of 5° by 5° was mounted in front of the radiator grille of the test vehicle at a height of 0.55 m. Evaluation trials were conducted both on a test track and on the highway. On the test track an Austin Maxi was used as the target car, and a light-sensitive paper recorder monitored radar performance. Where possible a true measure of range for comparison purposes was obtained by connecting the vehicles with a taut wire device. Initial tests were conducted on the test track under ideal low clutter conditions by approaching a stationary target car at a number of speeds. Results showed that around the crossover point the range and relative velocity outputs are subject to error so that the warning signal could be missed or delayed, but these effects were eliminated by use of the adaptive demodulation program. A series of highway tests were then undertaken to ascertain performance under practical road conditions. A video recorder was installed in the radar vehicle to record the road scene and display meters simultaneously. It was found that although satisfactory performance was obtained on the highway under predominantly single target conditions, false information frequently resulted when the radar scene was more complex. Missed warnings and erratic following performance occurred mainly in multiple target situations, and false alarms were caused mainly by roadside obstacles in the median when travelling in the fast lane on a curve. False alarms from vehicles in adjacent lanes were relatively scarce due to the delay in warning after detection. The poor performance in warning in multiple target situations was further studied in test track tests, showing that the accuracy and operating range of an FMCW automotive radar system are limited by multipath reflections, amplitude modulation effects, and backscatter from clutter. An operating range of 100 m is attainable with typical target cars but this is degraded at high speeds and in cluttered environments. Limitations imposed by radar beam and road geometry are limiting factors on development of such systems. It is concluded that a primary radar headway warning device suitable for use by the general motoring public is not at present technically feasible, but a radar system of this type could be used in more specialized applications where data can be interpreted by skilled personnel (such as in researching driver behavior).

by R. D. Codd; A. C. Downton
Joseph Lucas Ltd., Group Res. Centre, United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p128-31
1976; 5refs
Conference held in London 6-9 Jul 1976.
Availability: In HS-019 325

HS-019 357

HEADWAY RADAR USING PULSE TECHNIQUES

Development of headway radar using pulse techniques is described, enabling exact determination of the distance of an obstacle before a vehicle independent of visibility, taking into account road conditions, calculating the safe distance, and warning when the obstacle is closer than the safe distance. Such an autonomous system with a range of about 100 m has been developed. This system gives a warning signal to the driver when an obstacle is found in the direction of the primary vehicle's motion and when the distance is smaller than the safe distance calculated from vehicle speed, approach speed, braking deceleration, and reaction time. Distance, vehicle speed, and approach speed are monitored constantly. The reaction time is a fixed value based on experience, and the braking deceleration is set by the driver as a function of the road condition. The development of the distance radar centered upon resolution of two problem areas: distance measurement between two objects and determination of approach speed. Microwave detectors were chosen for these tasks on the criteria of cost, technical feasibility, and estimation of future development trends of components from a technological and cost point of view. Possibilities with signal evaluation in two autonomous distance radar systems were evaluated: frequency modulated (FM)-continuous wave (CW) and pulse radar. The FM-CW has low initial cost, but needs an expensive multichannel analyzer to achieve good resolution of obstacles sensed and measured for distance and approach speed. The FM-CW system is applicable in both spectrum analysis selecting nearest obstacle and spectrum analysis by sweep techniques. Processing time length and difficulties in the latter technique are considered problematic. The pulse radar method is better adapted to measurement of distances for collision warning equipment. Although the high-frequency cost is higher than with the FM-CW radar, signal evaluation is easier and less expensive. Short time delays in processing are another advantage to the pulse radar system. Pulse radar can also be set up to evaluate the structure of the reflecting object to differentiate between vehicles and other solid objects and transistory echo makers (such as rain). A pulse radar test system was constructed and tested, operating at a frequency of 9.26 GHz with a pulse power of 100 mW, a pulse duration of 80 ns, and a rise time of 10-15 ns. Tests showed good results for measurement of approaching obstacles, utilizing determination of relative speed of objects by differentiation of the distance signal. Results of further tests showed that a sensitive time control would be advantageous for suppressing undesired reflections from the close scattering range in front of the antenna. A risk computer was added which used measured distance, relative velocity, actual velocity, and three manually selectable road conditions or corresponding braking decelerations for vehicle and preceding vehicle to determine the necessary safety distance and to warn if that distance is not available. The basic feasibility of a high performance rear collision avoidance system using the pulse radar principle was confirmed by the test results. Further development will concentrate on eliminating false alarms, refinement of signal processing, increasing operating frequency, and development of an integrating antenna.

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VDO Adolf Schindling AG, Res. and Devel. Centre, Federal Republic of Germany
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p132-5
1976
Availability: In HS-019 325

HS-019 358

THE ADVANCED ELECTRONIC FUEL AND ENGINE CONTROL AND DIAGNOSTIC SYSTEM

An advanced electronic fuel and engine control and diagnostic system (the Plessey fuel system) is described. The basis of the system is the ultrasonic high response fuel injector, featuring a machined body having a length equal to half a sound wavelength in steel at the operating frequency of 60 kHz. A nodal face is situated at the midpoint of the body and the diameter is reduced on one side of this face, with fuel under low pressure introduced as near the face as possible. A piezoelectric ceramic element, lead zirconate titonate, is bonded to the large diameter end and an atomizing tip is incorporated in the small end. A ball valve is situated within the swirl atomizer and this ball is held onto its seat by fuel pressure when the injector is deenergized. When an energizing alternating current voltage at the design frequency is applied across the ceramic element, it is vibrated in a thickness mode, causing the injector to vibrate longitudinally. The amplified motion of the ceramic element causes the ball within the atomizer to unseat and fuel to emerge from the injector. Fuel within the swirler sets up a vortex and the ball lifts further off the seat under influence of ultrasonic and hydrodynamic forces. Fuel entering the swirl chamber axially via a small hole provides a closing bias which causes the ball to reseat as soon as the energizing voltage is removed. The electrical drive is provided by an oscillator circuit in three sections: switching circuit, oscillator, and output bridge circuit. Fuel is supplied to the injector from an electrically driven pump which regulates pressure of fuel supplied to injectors, at ranges of 15 psi to 100 psi (typical passenger car application is 40 psi). The fuel system has been tested on two vehicles, demonstrating improvements in hydrocarbon and carbon monoxide emissions over those obtained in a carburetor engine. The air/fuel ratio was improved to 15:1 with the Plessey system, improving fuel consumption by 19-20% under varied road conditions (highway, normal load, and town driving). Preliminary results on another vehicle showed that similar improvements were not being achieved, probably caused by inadequate mixing of the air and fuel droplets within the cylinder. An electronic carburetor was introduced to improve the system, using a single ultrasonic injector to distribute fuel into the inlet manifold at a central point. The mark-space ratio of fuel pulses is predetermined by inputs to the control unit, including air inlet temperature, throttle movement rate, engine coolant temperatures, and battery volts. Further improvement may be achieved through optimizing atomization with use of the ultrasonic injector system. It is concluded that exhaust emissions and fuel consumption in automobiles may be improved by accurately controlling the quantity of fuel supplied to the engine and the quality of fuel evaporation. The ultrasonic injector and electronic carburetor described offer viable and economical ways to achieve these objectives.

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The Plessey Co. Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p136-9
1976
Availability: In HS-019 325

HS-019 359

AFF - AN AUTOMATIC GUIDANCE SYSTEM FOR ROAD VEHICLES

A technical solution of lateral control of road vehicles fo plications where automatic guidance system is neede presented. In such a system road vehicles are automati controlled on special, exclusive road lanes, retaining the bility of being operated by a driver on public (nonautom streets and highways. The advantages of these systems urban transportation have been seen in mass transit sys using specialized vehicles only, and other areas of applic include the industrial use of trucks in an unhealthy env ment, life tests on rough roads, and monotonous transpo work in mines or similar fields where guided vehicles cou used advantageously. The lateral control concept introd makes use of a wire buried in the middle of one lane o road which is fed with an alternating current of betwee and 20 kHz. The vehicle is guided along this cable by closed loop control of the steering mechanism in such a that the cable is always kept under the middle of the vel Pick-up or antenna coils on the vehicle are used to ga deviation signal which is proportional to the deviation. deviations may emanate above an inhomogeneously reinfo concrete road or bridge, which leads to a strongly nonl deviation signal. The radiated signal might also be influe by weather conditions, damping by the vehicle, or load ch of the generator. The steering actuator selected uses an center principle with the standard steering pump. Si switchover for manual steering is accomplished by deenc ing an electromagnetic valve. The vehicle and steering act are described by a second order differential equation, v measures the deviation both in front of the steered vehicl behind the rear axle by two sets of coils. The theoretical on automatic steering vehicles was supported by testin truck with an automatic transmission and a weight of 1(was equipped with the guidance system designed and wa on proving grounds where more than 4 km of guidance were embedded in the road. These tests enabled a thor understanding of the problems of the guidance concept enabled optimization in the design phase, yielding param of performance specification, cost and labor predict safety device concepts, and longitudinal control equipr Safety devices considered included an antiskid braking sy and diagnostic programs for equipment malfunctions to e defective module exchange. Advantages of the system de include utilization of conventional components, simplici design, safety in design and operation, and economy of ir mentation on normal roads.

by H. Domann
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Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p140-3
1976; 6refs
Availability: In HS-019 325

HS-019 360

MOTORCYCLE BRAKING

Experimental work at Transport and Road Research Labo ry on an antilock braking system for motorcycles fitted hydraulic disc brakes is described. Factors affecting mot cle braking apart from those inherent in particular ma design were identified. Of these the weight transfer du deceleration and the effects of machine camber and corn

forces can have a marked influence on the braking performance and stability of the motorcycle. Combined with changing road surface conditions, particularly when wet, the motorcycle rider is faced with the task of stopping his vehicle under emergency conditions in the shortest distance without locking the wheels and losing control. The concept of providing an antilock braking system working independently on each wheel of a motorcycle was devised to provide optimum braking performance independent of load transfer and of the overbraking for a given set of conditions. The system would provide the rider with some ability to change his direction while braking under emergency conditions to avoid an accident. Early experimental work (1964) involved tests with front wheel antilock brakes using a full flow braking system, the brake fluid being supplied under pressure by an engine driven pump fed from a reservoir. The applied brake pressure was modulated by a Dunlop aircraft type Maxaret unit incorporating a flywheel overrun device which operated a hydraulic valve, so that in the overrun condition high pressure fluid from the pump and brake calipers was returned to the reservoir. Shorter stopping distances were obtained with the unit switched in compared with standard braking with the front wheel locked. Stronger substitute forks were fitted to resist the rapid succession of braking torques produced in the test machine, although the system produced was still experimental and not a prototype. Current work on the antilock brake system involves development for motorcycle use of an experimental system originally designed for cars. The system as installed on a motorcycle fitted with a hydraulic disc brake continuously monitors the speed of the braked wheel by a transducer and toothed wheel; whenever the wheel decelerates faster than a predetermined rate (due to overbraking), the logic circuit in the electronic control panel energizes the solenoid valve which releases the applied brake pressure. This action allows the wheel to recover its speed at which point the solenoid valve closes and braking is reapplied at a rate which depends on the degree of slipperiness of the road surface. This sequence is repeated as needed throughout the braking stop. Other antilock brake systems studied include a mechanical system and inertial brake control systems, but the efficiency of the hydraulic modulator and the electronic circuit braking control systems was not achieved. Future development of the electronic circuit antilock braking system will be carried out through inclusion in road machinery which can be tested in use by reporting riders, such as traffic police, before the final stage of design and development is begun. It is concluded that the braking system being developed offers an advance in motorcycle stability in braking and in adverse circumstances of operation on slippery wet surfaces. When a reliable production version becomes available, it could reduce road accidents of motorcyclists. Given sufficient demand to justify the costs of introduction (no more than 5% of retail price), the braking system could be modified for large-scale production and fitting to future motorcycles.

by P. M. F. Watson; F. T. W. Lander; J. Miles
Transport and Road Res. Lab., Crowthorne, United Kingdom; Mullard Ltd., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p144-51
1976; 3refs
Availability: In HS-019 325

HS-019 361

A DIGITAL ELECTRONIC SYSTEM FOR AUTOMOBILE TESTING AND DIAGNOSIS

The Autosense Computerized Digital Diagnostic System, a digital electronic system for automobile testing and diagnosis, was designed to assist mechanics at all skill levels to test and diagnose both older and newer vehicles. The system can run individual tests and thus be used by the mechanic as a tool, or automatically step the vehicle through a sequence of tests to diagnose a specific problem, totally check a vehicle's engine and electrical systems, or its individual systems. The system compares actual test results against manufacturers specifications and provides the mechanic and customer with a hard-copy printout of test results and recommended repairs. Key elements of the system include a means of obtaining parameters to be measured, intelligence to identify parameters which need investigation, ability to interpret the significance of each parameter value or measurement, logic process to perform comparison of these parameters against standards and to use data in identifying probable problem causes, and a method of displaying the diagnosis in understandable format. Operator interfaces with the system include entering vehicle identification information into the system, connecting the system to the vehicle harness, holding the hand controller in receiving cueing instructions and reading data instantaneously, and handling the printout materials. Hardware elements of the system include sensors, interfaces or signal conditioning units, computer, tape transport unit, printer, hand-held controller, and power supply. Sensors included are the current probe, engine timing, high voltage measurements, inlet manifold vacuum, emissions analyzer, and electrical access signals. Interfaces provided contain the signal conditioning circuits to convert vehicle sensor signals into a digital format compatible with the computer (input terminations, signal conditioning, multiplexed analog to digital converters, and digital interval counter). The computer is a 16 bit serial computer specifically developed for control and data acquisition storage. The tape unit is a basic cassette unit using a digital cassette as the bulk memory file for programs and specifications, utilizing an environmentally sealed tape transport unit in data transfer. The unit printer is a teletype type which has a normal data print channel and a timer to shut it off when not being used, with remote printer option provided. The hand-held controller is connected by a long cable to the system, enabling the operator to run tests from inside and outside the car and to receive cueing instructions and interface data while tests are being performed. Normal uses of the diagnostic system include tune-ups, periodic routine maintenance, customer complaints, predelivery vehicle preparation, used car presale preparation, mandatory emissions/safety inspections, and production line vehicle testing. It is concluded that the diagnostic system described offers improvements in time and accuracy in carrying out vehicle trouble diagnosis and simplifies the mechanic's task.

by T. A. Cross
Autosense Equipment Inc., United Kingdom
Publ: HS-019 325, Automobile Electronics. International Conference, London?, 1976 p152-9
1976
Availability: In HS-019 325

HS-019 362

ACCIDENT INVESTIGATION MANUAL FOR ANY TYPE OR SIZE OF MOTOR FLEET. HOW TO

INFORMATION TO MINIMIZE COSTS AND PREVENT OR REDUCE FUTURE ACCIDENTS

Information on how to assemble, analyze, and apply accident information from accident investigations to minimize costs and prevent or reduce future accidents is presented. Specific application is intended for motor fleet operations management. Three reasons and controlling attitudes for investigation are advocated: liability, prevention, and corrective action. With these objectives in mind, the investigator's activities are described, consisting of reporting the accident, selecting accidents for in-depth investigation, on-the-scene accident investigation activities, proceduralized data gathering, preparation of reports, recording accident information, driver and/or victim interviews, accident analysis, and testimony. Proceduralized approaches to each of these activity fields are presented, representing the attitude that meaningful procedures established and used by those involved will simplify the task of accident investigation and amplify the data available for use in the analysis. Accident investigation is considered as a professional activity, requiring openmindedness, lack of bias, poise, skill, and thoroughness. Fundamental information on results of the accident, paths followed by the elements involved prior to the accident, how they followed those paths, what happened during any impact, where did each element come to rest, and what did the driver do to avoid the accident is requisite for the investigator's use. On the scene the investigator observes and records conditions before, during, and after the accident (including physical evidence such as skid marks or paint transfer); records observers' and participants' statements; photographs the scene from various angles; records data to assist writing of the accident report; records information such as weather, light, and road conditions; and prepares accurate scale diagrams to aid in accident reconstruction. Off the scene the investigator makes direct observation of factors that could be relevant to the accident (such as noting drug prescriptions or personal habits); checks records of information possibly relevant to the accident (such as driving history or vehicle repair log); records opinions, recollections, and observations of witnesses; and observes the driver in other phases of his job. Careful preparation for and performance of accident investigations can yield data useful in defending against liability, preventing other accidents, and taking corrective actions (such as obtaining legal advice, disciplining the accident driver, and reconstructing the accident).

National Safety Council, 425 N. Michigan Ave., Chicago, Ill. 60611
1976; 34p 16refs
Availability: Corporate author

HS-019 363

APPROVING DIAGNOSTIC/REPAIR CENTERS--DOES THIS PROVIDE A MEANINGFUL SERVICE?

The Automobile Club of Southern California (ACSC) program for approving diagnostic/repair centers is described in the process of its institution, experience to date, response of the motoring public, and some possible future programs. The public service effort was instituted to improve the quality of automobile repair offered to the public by generally upgrading repair facilities and to provide a member service activity aimed toward providing the ACSC's members with a means for securing accurate vehicle problem diagnosis and quality vehicle repair. Seventeen approved diagnostic/repair centers ACSC's service area. These centers perform analysis inspections of vehicle components and performance in brakes, accessories, lights, underhood area, under vehicle area, wheel alignment, suspension, and balance; electrical system, fuel system, ignition system, engine, and transmission. Repairs needed may be carried out on-site or at the location of choice. The ACSC developed an effective program for approving such diagnostic/repair centers by setting goals of accurate reliable diagnosis, quality repair at realistic costs, and with provision for recourse through the ACSC when satisfaction was not obtained. The development effort proceeded according to consensus surveyed through 8,000 members, demographically selected as representative of the club's members. These respondents indicated that quality service was more important than low cost in obtaining needed repairs. Their general response to the idea of approving diagnostic/repair centers was favorable, although most indicated they favored a club owned and operated center. The club proceeded with the approved center plan as more economically feasible, considering three types of facilities: diagnosis only, diagnosis and limited repairs, and diagnosis and complete service and repairs except in reconstruction. Criteria for approval of facilities reviewed included minimum equipment in good working order, acceptance of most automobiles accepted for diagnosis, employment of sufficient numbers of qualified diagnosticians and repair mechanics, guarantee of repairs, provision of estimates for all work to be performed (listing parts separately), safe and attractive facilities for waiting customers, and agreement to settle disputes through the ACSC. The approval procedure also involves investigation of a shop's financial condition, resolution of previous complaints, a survey on the quality of services rendered to past customers, satisfactory diagnosis of anonymous test vehicles, establishment of professional and community reputation, and observation of repair procedures and effectiveness. Experience to date indicates few complaints and satisfactory resolution of those complaints in a large volume use. The high cost of needed equipment and high standards required for approval are limiting factors on continuation or expansion of the ACSC program, but some expansion is expected in approving repair-only garages within the club's member service area. An ACSC headquarters diagnostic facility has also been constructed to monitor the approved center program, to provide assistance in the resolution of member complaints, to provide training for diagnosticians, to develop new diagnostic techniques and to provide assistance toward up-grading the repair industry.

by Maury Kramer; Louis J. Bintz
Automobile Club of Southern California
Rept. No. SAE-760145; 1976; 15p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 364

SOUND ATTENUATION KIT FOR DIESEL-POWERED BUSES. FINAL REPORT

An optimized commercially-available exhaust, intake, and fan subsystem for a typical diesel-powered city bus is described after assessment and demonstration. The subsystem was designed as retrofit equipment for current vehicle fleets, while maintaining public safety and established vehicle exhaust emission regulations. Performance tests on buses before and after retrofitting with the kits described were performed to ascertain

the sources of major noise in buses and to determine the best means of treating noise sources. Major bus noise sources were identified as engine mechanical noise, air intake, exhaust, radiator cooling fan, transmission, and aerodynamic influences, with tire and air conditioning noises excluded from study. The emphasis in treatment of these noise sources was on making modifications as practical as possible, bearing in mind manufacturing cost, materials, and impact on vehicle maintainability. Efforts were concentrated on replacing existing items with acoustically superior units, adding extra treatment only where necessary. Total encapsulation can provide the greatest reduction in noise generated by the engine and its auxiliaries, but the effect on the total system noise reduction depends upon contribution of other components and is relatively small when an engine capsule is used. Total encapsulation also causes difficulties by increasing cost, weight, engine cooling problems, and maintenance interference. Rather, use of acoustically absorbent lining material where possible in the engine compartment was tried, resulting in engine overheating. Noise from valve rocker arms was reduced effectively by replacing their steel covers with parts made from a nonresonant laminate. The engine air intake system was concluded to be optimal as furnished. Acoustical performance of the engine exhaust system was improved by reducing noise radiation through the muffler shell, increasing the exhaust pipe system in diameter, and furnishing a system resonator. The noise from the radiator cooling system could be treated by increasing radiator and fan size, slowing down the revolution rate, correcting radiator/fan spacing, and furnishing shrouding. Engine overheating was a common problem in all attempts to prevent noise leakage from the engine compartment. Transmission noise isolation proved impossible, but maintenance of the drive train somewhat minimized noise levels. It was determined that overall acoustical treatment of the engine compartment and carrying on recommended maintenance of vehicle components were as effective as any single measure tried, to reduce bus noise. Test configurations determining noise levels before and after treatments attempted are presented in each category, listing components of modification kits developed. Kit 1 has the improved exhaust system, damped steel rocker arm covers, and acoustical material on the hood and transmission door. Kit 2 adds the contoured fan shroud and an engine partition. Acoustic tests and a cost analysis of use of these kits on buses resulted in a useful amount of noise reduction, obtainable with relatively minor changes. Test plans, service information, and acoustic test data are presented in appendices.

by James C. Berry; David L. Overgard
Rohr Industries, Inc., Chula Vista, Calif. 92012
Contract DOT-TSC-714
Rept. No. DOT-TSC-OST-76-5; 1976; 232p
Rept. for Feb 1974-Feb 1975.
Availability: NTIS

HS-019 366

EMERGENCY MEDICAL SERVICES IN ARIZONA. A SITUATION REPORT TO THE ARIZONA DEPARTMENT OF PUBLIC SAFETY

A report on emergency medical situations most likely to occur in Arizona is offered with recommendations to meet the need for emergency medical services (EMS) and to improve the effectiveness of ambulance services and emergency receiving facilities in the state. Goals are to provide EMS for residents and visitors regardless of ability to pay; to provide adequate information concerning the availability, location, and procedures for utilizing EMS; and to continue development of EMS systems in accordance with the concept of regionalization of health services outlined in the Arizona Plan for Health Services. Emergency medical situations in Arizona which may occur with relevance to need for EMS include vehicular accidents, home and public facility accidents, occupational accidents, general emergency health needs, heart attack incidents, and premature births. Recommendations made with regard to providing EMS for traffic situations include promotion of driver and safety education of public and in schools, promote legislation for vehicular inspection, develop and implement medical criteria for driver licensing, promote defensive driving techniques, provide highway signs identifying EMS facilities, and determine feasibility of providing toll-free call boxes on highways for EMS. A statewide program to provide public information on injury prevention and control is recommended to assist EMS in home and public accidents, while first aid training to meet standards of the Occupational Safety and Health Act is proposed to deal with the EMS for occupational accidents. General EMS facilitation can be extended to include all Arizona citizens in the State Medical Self-help Training Program and by initiating in a single EMS telephone number to reach and dispatch needed help. Recommendations for heart attack EMS include expanding public and professional education, prevention, training, and rehabilitation programs. The EMS plan for premature newborns consists of continuing and expanding the program for transporting and providing intensive care of the newborn on a statewide basis. Recommendations are also made to improve ambulance services, ambulance personnel qualifications, and hospital emergency receiving facilities, based on planning, funding, and training or retraining for EMS goals. The promotion of a State Center for Health Information is a stated goal so that effective compilation of health information essential to the program's development can be achieved. The leading causes of death in Arizona in 1972 are listed as heart disease and related disorders, cancer, and accidents in that order. These accounted for 10,841 or 69% of the 15,779 deaths of 1972. Table 1 lists these deaths by county and type of death. Over 641 lives were lost in Arizona in 1972 from accidents occurring at home, work, or in public. Table 2 shows the principal classes of accidental deaths by county. It is felt that priority must be given to preventive programs which focus on accidents. Heart and blood vessel diseases were responsible for 43% of all Arizona deaths in 1972. About 2,250 victims of heart attack expire before reaching a hospital. For this reason, appropriate transportation equipped with suitable equipment and manned by well trained personnel must be a priority goal. Descriptions of Arizona ambulance services, licensed hospitals, and a classification system and criteria of EMS facilities and assistance are appended.

Arizona Health Planning Authority, 2980 Grand Ave.,
Phoenix, Ariz. 85017
Rept. No. HRP-0004526 ; 1973; 65p 2refs
Availability: NTIS

HS-019 367

INFLATABLE BODY AND HEAD RESTRAINT

A vehicle occupant restraint system which inflates upon impact includes lap and shoulder harnesses which resemble conventional restraint systems in their uninflated state, but which inflate upon impact, as does an additional inflatable bladder which cushions the chest area and minimizes head rotation

toward the chest. The object of the invention is to provide an automatic restraint device which includes the means for minimizing forward whiplash movement of the head in an accident situation. The restraint system inflates upon a threshold impact to form a body buffer for the vehicle occupant, in a system which can be integrated with a conventional strap restraining system in the uninflated or stowed condition and which is constructed for convenient ingress and egress. The restraint system is provided with integral, porous bladder structures formed from a loosely woven synthetic material. In the uninflated state the bladders are folded accordion-like and loosely stitched down to resemble conventional webbing. An integral gas generator is located centrally with respect to the harness in a terminus housing. Upon impact a sensor switch closes and supplies energy to fire the gas generator. The bladder structures which form the major portions of the lap and shoulder harness inflate virtually instantaneously as does an additional bag of material which unfurls across the chest to minimize head rotation into the chest. Advantages of the invention are its automatic operation, low cost, attractive appearance, ease of stowing, reliability, and effectiveness in preventing injury.

by Marvin Scholman
Department of the Navy, Washington, D.C.
Rept. No. AD-D001 257; 1974; 13p
Serial No. 483,603; filing date 27 Jun 1974.
Availability: NTIS

HS-019 368

COMPLETED STUDIES HIGHWAY TRAFFIC AND SAFETY EDUCATION 1964-1973

Highway traffic and safety education research conducted at the Safety Center, Southern Illinois University, Carbondale, Ill., from 1964 to 1973 is presented in the form of 43 summaries which contain information on study purposes, methodology, data, conclusions, and recommendations. Topics researched include: driving knowledge related to violation and biographical characteristics; braking methods; driving simulation programs; school bus driver selection; safety and driver education graduate degree programs; traffic law in driver education; driver improvement and control programs; motorcycle instruction in secondary schools; emergency medical service; handicapped drivers; alcohol involvement in traffic; student accident data; drug use and abuse in traffic; bicycle safety; student contract teaching; attitudinal surveys; and automobile preventive maintenance. Certain trends in teaching driving in U.S. secondary schools are scrutinized by the studies, including student contract teaching, drug and alcohol education, attitudinal and motivational factors, and evaluation of driving education programs.

by James E. Aaron; Larry Lindauer; Dale O. Ritzel, comp.
Southern Illinois Univ., Safety Center, Carbondale, Ill. 62901
1973; 64p 1ref
Availability: Reference copy only

HS-019 369

WHAT GOOD ARE OCTANES?

A discussion of the need and effects of gasoline octane ratings on engine performance is presented, utilizing definitions of terminology, background on octane valuation, basic combustion principles influencing knock, and chemical properties of gasolines that influence octane quality. Service-station pump labels are required to carry information on the octane quality of gasoline for sale, i.e., its ability to prevent detonation during the combustion process in a spark ignition engine. Lead antiknock additives and refining processes influence the octane quality of gasoline. The label terms include RON (Research Octane Number); MON (Motor Octane Number); RDON (Road Octane Number), describing how the fuel would perform in a car on the road; and the lifesaver symbol to display the lead content and octane quality of the fuel indicating driveability and cleanliness characteristics. During the past 20 years both RON and MON trade gasolines have gradually increased, prompted by the 1950's development of engines with higher compression ratios which increased fuel economy and better performance. Octane quality leveled off and started down by the early 1970's, brought about by the advent of new lower compression ratio engines designed to run on unleaded gasoline required by concern with environment. Since it is economically and conservationally difficult to produce high octane unleaded gasoline, compression ratios have decreased further. As exhaust emission control has become a dominant factor in engine design, it has increased the emphasis on engine and car designs for optimizing fuel economy. Two self-ignition processes occur related to the octane quality of the fuel used: knock and after-run. Several engine design and operating variables have been found to affect the knock phenomenon, including compression ratio, spark timing, combustion chamber design, air/fuel ratio, coolant temperature, engine speed, throttle opening, exhaust diluent, combustion chamber deposits, inlet air temperature, pressure, and humidity. After-run phenomena occur as an effect of abnormal compression ignition, varying with the relation of octane quality of fuel to throttle opening. The same variables which influence knock determine an engine's octane requirement, and that requirement is determined in a specific test procedure used with one or more series of reference fuels. The fuel giving borderline knock is determined, and the octane value of that fuel is defined as the octane requirement of the engine. An attempt is made by the automotive manufacturer, petroleum refiner, and their mutual customers to match the engine's octane requirement with a fuel of adequate octane quality in order to eliminate knock and after-run and to avoid wasting gasoline. A case of matching fuels and engines is given as an illustration of the meaning contained in posted gasoline octane ratings. A gasoline performance and information system has been developed by the ASTM (American Society for Testing and Materials) to aid the consumer in selecting the proper fuel for his car.

by Jack Benson
Publ: Chemtech p16-22 (Jan 1976)
1976; 17refs
Availability: See publication

HS-019 370

THE CPSC (CONSUMER PRODUCT SAFETY COMMISSION) ROAD TEST OF BICYCLE BRAKING PERFORMANCE -- KINETIC AND ERROR ANALYSES. FINAL REPORT

The Consumer Product Safety Commission (CPSC) has promulgated a safety standard for bicycle braking systems based on the stopping distances achieved in road tests under specified conditions; also, an error analysis of the test method for the CPSC's use in justifying or modifying the test criteria was performed, based on experimental data and on theoretical

principles. The theory, a kinetic analysis of the bicycle braking process, is included, together with proposed definitions of terms intended to quantify important aspects of bicycle braking performance. The error analysis produced estimates of large interlaboratory and test-to-test variations to be expected from the test method. These in turn were found to be principally dominated by errors resulting from an incorrect overweight-rider allowance specified by the CPSC, and by variations in rider reaction times, respectively. Suggestions are made for more accurate methods of accommodating variations in rider mass, for reducing the effects of the test-to-test variability, and for reducing the danger of pitchover in the performance of the road test. Suggestions center upon reducing subjective factors in tests, putting emphasis on dynamometer-type laboratory testing rather than on road testing. Some measures may be used in road testing, however, to improve quality of results, such as: alternating test runs in opposite directions to reduce the influence of roadway incline and wind effects; using automatic systems for applying required forces to handbrake levers to eliminate variability in rider reaction times and pressures; and using a decelerometer to measure peak performance during the road test to improve accuracy. Concepts of brake sensitivity and braking capability are defined, enabling a bicycle's braking performance to be quantified and discussed in tangible terms and to be evaluated in a relevant performance framework. Test parameters influencing results of the CPSC road test are identified as variable rider weight and reaction times, leading to suggestions for improving or sometimes eliminating road test procedures. A two-dimensional analysis of the kinetics of bicycle braking was developed, yielding equations of motion for various combinations of skidding and rolling wheels to provide a basis for estimating errors attributable to variations in test parameters and enabling formulation of threshold conditions for pitchover instabilities. Various errors encountered and projected in the performance of the road tests were combined to arrive at quantitative estimates of the test-to-test and interlaboratory variability of observed stopping distance, casting doubt on the validity of the present test method. Error analyses were prepared for three specific bicycle braking test systems in order to characterize them: the National Bureau of Standards test system, the Bicycle Safety Regulation required system, and the ideal testing system (characterized by qualitative controls to allow less variable results (errors) among tests).

by Leonard Mordfin
National Bureau of Standards, Inst. for Basic Standards, Washington, D.C.
Rept. No. NBSIR 75-786; PB-251 411 ; 1975; 77p 30refs
Availability: NTIS

HS-019 371

CHARACTERISTICS OF THE REGULAR ADULT BICYCLE USER. FINAL REPORT

A mailback questionnaire of adult bicycle riders who ride at least three times a month was completed and returned by 50% of 8,405 members of the League of American Wheelmen, and 3,270 were used in the final analyses. Demographic and bicycle description data and information were recorded along with trip characteristics and accident experience for the year 1974. An estimate of miles traveled was calculated through the respondents' use of odometers. Over a third of all subjects reported using an odometer; those not using them reported mileages that did not differ significantly. The subjects traveled an average of 2,332 miles during 8.9 months that they rode a bicycle. Males rode about 40% more miles than females and had an accident rate 60% lower than females. The oldest respondents (ages 66-82 years old) traveled on the average more miles than any other age group, but experienced the lowest accident rate. As cycling experience increased, accident involvement appeared to decrease. Almost one out of every 17 subjects was involved in a collision or serious fall that required medical treatment. Bicycle accident rates appear to be about twice as high as motor vehicle accident rates; age, sex, and years of experience of the bicycle rider influence the rate. The data also suggest that safety-conscious individuals (wearing helmets, using rearview mirrors, and always obeying laws) are involved in fewer accidents than others. Recommendations are made to sample local bicycling organizations in different areas of the U.S. to compare riding characteristics of their members with the national data presented, to survey other segments of the bicycling population (casual weekend riders, exercisers, and senior citizens), and to concentrate research on respondents in certain states to ascertain applicability of data gathered. Survey materials and analytical data are presented in appendices.

by Jerrold A. Kaplan
1975; 138p 42refs
Master's thesis, Univ. of Maryland.
Availability: NTIS

HS-019 372

TRAFFIC INJURY RESEARCH FOUNDATION OF CANADA. PROCEEDINGS OF THE ANNUAL CONFERENCE, OTTAWA, NOVEMBER 28, 1975

Topics covered include a survey of practices of coroners and testing laboratories in alcohol and drug determinations in traffic fatalities; estimated blood alcohol concentrations of nighttime Canadian drivers; the evaluation of countermeasures for traffic accidents and fatalities; stability of accident and collision rates among drivers with changing demerit points; and a study of the causes, sites, management, and outcome of 2,000 seriously injured persons in the Ottawa, Canada, region in 1974. The survey of practices of coroners and testing laboratories showed a wide variability in procedures and content, indicating that interpretation of data gathered from these sources may be difficult. Roadside survey of the blood alcohol concentration 0BAC0 of Canadian drivers in night hours showed a positive correlation between selected demographic and driving variables and BAC, including early-morning hours, male gender, marital problems, and age group 30-34 years. The countermeasures study indicates that most countermeasures are not cost-efficient due to their lack of specificity in defining the population at risk, indicating the need for increased availability and reliability of data-based knowledge in construction of cost-effective countermeasures. Characteristics of drivers at different demerit point levels were studied in relation to their different risks of conviction and collision, finding that demerit point level was a good predictor of future accident involvement. The injury study showed that more injuries took place on the road than elsewhere and that injuries associated with vehicles were commonest, with a tendency to take injured persons to the nearest hospital. Reports maintained at various levels of injury management may prove to be useful in recon-

structing accidents to determine causes and to prevent future accidents.

Traffic Injury Res. Foundation of Canada, 1765 St. Laurent Blvd., Ottawa, Ont., K1G 3V4, Canada
1976; 130p 13refs
Includes HS-019 373--HS-019 377.
Availability: Corporate author $1.50

HS-019 373

ALCOHOL AND DRUG DETERMINATIONS IN TRAFFIC FATALITIES: A SURVEY OF THE PRACTICES OF CORONERS AND TESTING LABORATORIES

Two national surveys to ascertain the practices and procedures of coroners and/or medical examiners as well as laboratory testing agencies were carried out. Principal focus was on practices or procedures that could affect the reliability or comparability of information relating to alcohol and drug involvement in traffic fatalities. Results of the surveys showed that there are considerable variations in the practices relating to alcohol and drug determinations in traffic fatalities. These variable practices are especially relevant when considering and making intraprovincial comparisons of data. Many disparities occurred with such low frequency that in the overall aggregate picture, their effects were nominal, but some differences (such as the frequency of testing for drugs) indicated a problem in making meaningful interpretations of national data. Variations were indicated in professional composition of those surveyed, legislation and authority which enabled their professional activities and sometimes the method and extent of their activities, and circumstances and procedures for alcohol and drug determinations. Differences in the latter category appeared in frequency of testing, selection of persons for testing, reporting and records systems used, and varying laboratory techniques in ordering, collecting, testing, analyzing, and evaluating samples. Three recommendations are made to improve the quality and quantity of data available: attempt at a national level to introduce a greater degree of standardization of practices and procedures to insure comparability of data obtained; establish qualifications and precautions with respect to data interpretation; and introduce routine testing for drug involvement as well as alcohol involvement in traffic fatalities.

by H. M. Simpson; Bruce Heayn
Traffic Injury Res. Foundation of Canada, 1765 St. Laurent Blvd., Ottawa, Ont., K1G 3V4, Canada
Publ: HS-019 372, Traffic Injury Research Foundation of Canada. Proceedings of the Annual Conference, Ottawa, 1976
p1-23
1976
French summary. Conference held in Ottawa, 28 Nov 1975.
Availability: In HS-019 372

HS-019 374

ESTIMATED BLOOD ALCOHOL CONCENTRATIONS OF NIGHTIME CANADIAN DRIVERS

A national roadside survey of blood alcohol concentration (BAC) of the nighttime driving population was carried out in 1974 to assess the extent and nature of driving after drinking in Canada. The survey was conducted on each Wednesday, Thursday, Friday, and Saturday of a 12-week period. In the course of the survey project, over 9,700 drivers were stopped between the hours of 10 P.M. and 3 A.M. at 582 randomly selected sites. Each driver was asked to voluntarily provide a breath sample and information on drinking and driving habits, trip length, and basic demographic characteristics. Examination of the relationships between estimated BAC's and selected demographic and driving variables is reported. Variables used in the weighted analysis included time and day of survey for drinking drivers and for drivers with over 0.095% BAC, region, urban/rural sites, weather, road condition, posted speed limits, trip duration, age, sex, level of education, employment, marital status, and seat-belt usage. The survey found that 20.4% of nighttime drivers had been drinking prior to driving, that approximately 40-45% of all drivers fatally injured in nighttime traffic accidents have BAC's of 0.10 or greater, and 4.1% had BAC's equal to or greater than 0.095%. These data suggest that the impaired driver is 16-20 times more likely to be fatally injured than the sober driver. Results of the survey indicated that the chance of meeting a drinking driver more than doubles between the two hours prior to midnight and the 1 A.M. to 3 A.M. time period. Drinking and driving incidence was found to be almost as high on weekdays as on weekends. Whereas the greatest percentage of drinking-driving occurred on Saturday mornings, the highest impairment percentage appeared during early morning hours on Fridays. Results revealed little differences in drinking-driving patterns among regions, but percentages of drinking-drivers and impaired drivers were highest in British Columbia and lowest in the Maritimes. Driving after drinking was most prevalent among males, among the middle-aged, among the unemployed, and among separated and divorced drivers. Other variables examined such as level of education, seat belt usage, and trip duration, showed only slight differences for drinking drivers and nondrinking drivers.

by G. Smith; M. Wolynetz; M. Davidson; H. Poulton
Publ: HS-019 372, Traffic Injury Research Foundation of Canada. Proceedings of the Annual Conference, Ottawa, 1976
p24-49
1976; 10refs
French summary. Conference held in Ottawa, 28 Nov 1975.
Availability: In HS-019 372

HS-019 375

THE ELUSIVE QUEST FOR CAUSALITY IN TRAFFIC FATALITIES: IS A POUND OF PREVENTION WORTH AN OUNCE OF CURE?

In searching for causality in traffic fatalities, extensive use is made of driver fatality data relevant to current and tentative countermeasure initiatives aimed at the alcohol impaired driver problem. These countermeasures may or may not be cost-effective in reducing traffic fatalities. Study of 1,725 driver fatalities within five Canadian provinces in 1973 is reviewed in an attempt to demonstrate the potential utility of concrete, data-based knowledge in contingent prediction and countermeasure design. Traffic Injury Research Foundation driver fatality data were applied to impaired driver countermeasures as a demonstration of data-based design limitations. The current 0.08% blood alcohol concentration legal impairment limit and several temporally-based countermeasures were evaluated with use of the data in terms of cost-effectiveness, and were found to be largely cost-inefficient due to their lack of specificity in defining the population at risk. The need for an increased availability and reliability of data-based knowledge is suggested as an essential precondition in the construction of cost-effective countermeasures. In this regard, knowledge of

haracteristics of the fatality population is viewed as being ecessary but not sufficient for effective countermeasure lesign. In order to properly delineate the population at risk, nowledge about how the characteristics manifested within the lead-driver population differ from those characteristics nanifested within the general driving population is needed. A comparison of males and females as high-risk drivers shows hat female drivers are less likely to die in fatal crashes than are male drivers even when driver exposure is controlled for, nd that the majority of this risk differential can be accounted or by the increased frequency of impairment observed within he male segment of the driver population. Thus the element f prediction has not been considered in gathering and using ccident data relating to the construction of countermeasures. Until prediction is improved, the countermeasures proposed nd used will remain cost-ineffective.

by Reg Warren
Traffic Injury Res. Foundation of Canada, 1765 St. Laurent Blvd., Ottawa, Ont., K1G 3V4, Canada
Publ: HS-019 372, Traffic Injury Research Foundation of Canada. Proceedings of the Annual Conference, Ottawa, 1976 p50-69
1976; 3refs
French summary. Conference held in Ottawa, 28 Nov 1975.
Availability: In HS-019 372

HS-019 376

THE STABILITY OF ACCIDENT AND COLLISION RATES AMONG DRIVERS WITH CHANGING DEMERIT POINTS

A group of 500-600 licensed Ontario drivers from each of five different levels of demerit points were studied to ascertain the characteristics of drivers at different demerit point levels (0-2, 3-5, 6-8, 9-11, 12 plus) and to identify factors related to their different risks of conviction and collision. Although differences in collision rates existed for sex differences of drivers, class of license, and to some extent between age groups, level of demerit points were concluded to be the best predictor of future accident involvement in these drivers. In studying experiences of these drivers for 4.5 years, it was found that the actual level of demerit points decreased in drivers initially at high levels but that the average points of these drivers remained at higher levels than other drivers. The incidence of convictions and the rate of accumulation of points remained consistently different in the five groups of drivers. Similarly, the risk of collision remained different in the five groups for the first three years, but in the last study period the risks of collision among drivers who had six points or more initially were almost the same. The risks of collision among drivers with fewer points initially remained stable at much lower values. In summary, the demerit point system seems to be a good predictor of future driving behavior. The number of further points acquired is reasonably stable over time, as is the number of convictions registered by drivers in each point group. A critical factor in using demerit points as a predictor is access to point accumulation within the recent past.

by Mary L. Chipman
University of Toronto, Toronto, Canada
Publ: HS-019 372, Traffic Injury Research Foundation of Canada. Proceedings of the Annual Conference, Ottawa, 28 Nov 1975 p70-86
1976
French summary. Conference held in Ottawa, 28 Nov 1975.
Availability: In HS-019 372

HS-019 377

PRELIMINARY REPORT ON A STUDY OF THE CAUSES, SITES, MANAGEMENT AND OUTCOME OF 2,000 SERIOUSLY INJURED PERSONS IN THE OTTAWA REGION IN 1974

A study of the causes and management of injuries in 1974 in the Ottawa, Canada region (Pembroke, Hawkesbury, Kemptville, centering on Ottawa) was carried out. The study involved an inventory of 16 hospitals in the region (staff, size, space and equipment devoted to emergency medical services, etc.); examination of the hospital records of some 2,000 cases which had been admitted to hospitals with injuries of the head, chest, abdomen, and pelvis, and fractures of the shaft of the femur and tibia; examinations of police and coroners' records for details about the site and time of accidents and the causes of deaths; and examination of ambulance records. All age groups up to 70 years and both sexes were involved in all types (by cause) of injury with younger males (up to 30 years) forming the largest group in every category. More injuries took place on the road than anywhere else, and injuries associated with vehicles were commonest of all types. Vehicles were involved in the majority of severe and of multiple injuries. There was a tendency to take injured persons to the nearest hospital, from where a majority of severe injuries were transferred to Ottawa. Few cases of great severity and few multiple wounds were retained in peripheral hospitals, and mortality in these hospitals was low. The sites of fatal accidents were widely distributed throughout the region, with concentration not obvious within the population. Overall the management of the injured seemed to be adequate, but it was noted that aggressive resuscitation attempts by emergency medical servcie personnel might have saved additional lives. The findings of the study suggest that records kept by police, coroners, ambulance services, and hospital personnel at different stages of injury management contain information which when assembled could give a better picture of events surrounding and following an accident which could be useful in planning preventive treatment measures and for general accident monitoring purposes.

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Traffic Injury Res. Foundation of Canada, 1765 St. Laurent Blvd., Ottawa, Ont., K1G 3V4, Canada
Publ: HS-019 372, Traffic Injury Research Foundation of Canada. Proceedings of the Annual Conference, Ottawa, 1976 p87-126
1976
French summary. Conference held in Ottawa, 28 Nov 1975.
Availability: In HS-019 372

HS-019 378

THE REQUIREMENTS FOR BATTERIES FOR ELECTRIC VEHICLES

The role of electric vehicles in the U.S. transportation system and their potential impact on oil consumption in the future are assessed. It is premised that a sizeable impact on oil use can come from using electric vehicles to replace conventional cars for personal transportation, as well as continuation of the trend toward use of electric delivery trucks. Three factors are seen as determinants of the size of the impact; market potential for electric vehicles, date of introduction, and the rate of consumer acceptance. Market potential is assessed in terms of the role assigned to the electric car in the national transportation system. A realistic role is suggested, such that utilization

of the electric vehicle will increase until intracity travel needs are satisfied. Any increase in utilization beyond that point is not feasible or necessary until intercity range and speed capabilities are achieved. The major early market for electric cars is predicted to be in households of two or more automobiles as a minimum target (26 million such households at the present time). The year when electric vehicles are available to the consumer depends on when batteries are developed which satisfy the requirements for an urban car. Three levels of battery technology will become commercially available at different times, resulting in different vehicle performance capabilities. Near-term batteries are of the lead-acid type; mid-term batteries (nickel-zinc, nickel-iron, and iron-air systems) are in a relatively advanced state of development but are presently not commercially available; far-term batteries are still in the laboratory research stage. Range requirements for urban cars have been developed showing that a daily driving range of 82 miles meets the public's needs on 95% of the days of the year. This results in the near-term vehicle being adequate 81% of the time, a mid-term vehicle 95%, and a far-term vehicle, 98% of the time. The market growth rate or the rate of consumer acceptance is viewed as a function of cost-effectiveness and adequacy in meeting consumer needs for transportation. In addition, significant petroleum fuel savings are projected at each stage of market penetration by stages of battery development. (25% minimum beyond the year 2000). It is recommended that development of electric vehicles using near-term and mid-term battery systems be accelerated, and that development of far-term battery systems be delayed in the interest of more immediate fuel savings. A strategy of early introduction of near-term and mid-term electric vehicles followed by incorporation of improvements in battery technology as they occur in the future is seen as productive of the optimum result in fuel savings to the year 2000 and beyond.

by Harvey J. Schwartz
Lewis Res. Center, Cleveland, Ohio 44135
Rept. No. NASA-TM-X-71916; N76-21701; 1976; 7p 10refs
Prepared for presentation at 27th Power Sources Symposium, Atlantic City, N.J., 21-24 Jun 1976.
Availability: NTIS

HS-019 379

POST LICENSING CONTROL REPORTING AND EVALUATION SYSTEM. IMPLEMENTATION REPORT

The Negligent Operator Component, one of six administrative actions in the Driver Licensing and Control Program, is a significant component of the Post Licensing Control (PLC) reporting evaluation system. This component deals with nearly 55% of the total PLC subjects and accounts for 32% of the total PLC budget. This system cannot be extended to evaluating other components, as questions must first be answered regarding funding for such an effort, the need for the component, and determination of which critical factors should be evaluated and how. To derive treatment cost data for the Negligent Operator component, a cost model was developed to determine direct, indirect, and fixed labor costs for each of the four treatments (warning letter (W/L), group educational meeting (GEM), individual hearing (I/H), and probation violator hearings (P/V)) using data inputs from several Department programs; results are stated in terms of total "task" costs and unit treatment costs within each task. These costs were then validated independent of the cost model by using alternative cost development techniques and comparing results of the two efforts to determine relative errors. For a variety of reasons, however, the validation study developed cost results significantly lower than cost data generated by the cost allocation system. The validation method appears to be the more definitive because it used a direct measurement tool that contained fewer computational steps with no subjective judgment factors. "Cost of Treatment" results are presented for each type of treatment in each of the five areas of the State. Area costs are derived from personnel allocations, which are used to assign dollar values to the cost of providing each of the PLC treatments. The total cost of the Negligent Operator component for the 13 months of this study was $4,709,061. Cost for evaluation of this component was $374,208. The experimental design measured the effect of the Negligent Operator treatments on accidents and traffic violations by assigning subjects randomly to treatment and control conditions. No compelling bias was evident in the assignments. Several methods of data analysis were used: power analysis and survival curve analysis of time effects. The findings were as follows. Regarding convictions, all Negligent Operator treatments were highly effective in reducing convictions. All of the Negligent Operator treatments except GEM are effective in reducing accidents. The GEM effects are in the desired direction but not of sufficient magnitude or consistency to reach statistical significance at this time. The treatments are effective over a period from 120 to 240 days, depending on the type of treatment. Two estimates of cost-benefits are used. The range of "net savings" figures demonstrates the difference in indicated savings under different assumptions used in the cost-benefit computations. The lack of definitive benefit estimates is the weakest link in the cost-benefit analysis of accident prevention programs. However, the low estimate of benefits still yields a net figure of $175,321. Results for the W/L treatment are also clear -- it is highly cost-beneficial with any of the estimation techniques used. The cost-benefit results for the other treatments are not as consistent; whether or not a treatment is cost-beneficial depends on the particular cost and benefit estimate used. However, the I/H was cost-beneficial with the majority of the indices used and was by far the most effective treatment on the basis of net accident reduction.

Department of Motor Vehicles, Div. of Drivers Licenses, Calif.
1976; 110p 7refs
4th of a series and final rept.
Availability: Corporate author

HS-019 382

PEDESTRIAN SAFETY. SEMINAR, ST. CLOUD, MINNESOTA, 24-25 APRIL 1975

Topics covered include alcohol involvement in pedestrian collisions, the safety aspects of walking, pupil transportation, school pedestrian safety, alcohol involvement in pedestrian safety, and pedestrian conspicuity under the standard headlight system as related to driver perception. A bibliography on pedestrian safety incorporating references made in separate papers is included.

St. Cloud State Univ., Minnesota Hwy. Safety Center, St. Cloud, Minn. 56301
1975; 62p 87refs
Includes HS-019 383--HS-019 387.
Availability: Corporate author

HS-019 383

ALCOHOL INVOLVEMENT IN PEDESTRIAN COLLISIONS

A review of the literature on the involvement of alcohol in pedestrian collisions resulting in death and injury is summarized as presenting typically little knowledge regarding the problem of alcohol related to pedestrian safety. The small amount of information which is available and the similarity of the pedestrian-alcohol situation to the more extensively researched area of drinking-driving enable some estimates of what fields of information are not known and how the needed knowledge can be acquired. Three types of information are currently available concerning the pedestrian-alcohol problem: postmortem blood alcohol concentration (BAC) measurements on fatally injured pedestrians; data from controlled study of pedestrian accidents related to alcohol; and qualitative assessments of the presence of alcohol in crash victims. Postmortem BAC measurements have been gathered in some cases to specifically investigate the pedestrian-alcohol problem, while in others they are part of the routine procedure reporting of coroners or medical examiners. These data on fatally injured pedestrians do not provide a picture of the nature and extent of the problem, as they are limited to incidents of fatality and do not show incidence of injury only. Data from the postmortem examinations show a mean occurrence of alcohol in tests on fatally injured pedestrians as around 45%. Problems with existing data concerning the fatally injured pedestrians include over-emphasis on the alcohol factor, exclusion of victims with some survival time or under 14 years of age, and estimation of alcohol's role in these accidents. Only one controlled study was found, presenting BAC data on 19 fatally injured pedestrians compared with 76 site-matched controls. The small sample size and the uniqueness of the study prohibits drawing conclusions about the alcohol involvement of pedestrians who are or are not injured or killed. Qualitative assessments of the role of alcohol in pedestrian accidents in another unique study have provided information on the dynamics of the alcohol-involved pedestrian crash. Data from 2,000 pedestrian accidents in 13 U.S. cities were used, finding alcohol use correlation among pedestrian accidents in aspects of pedestrian behavior such as darting and dashing out into traffic, pedestrian errors, pedestrians aged 25 to 64 years old, adult male pedestrians, ethnic minorities, association with increase in injury severity, and parallels with the driver alcohol problem in terms of time of day and day of week (at night and on weekends). The need for controlled epidemiological study focused upon both fatal and nonfatal pedestrian crash events is demonstrated.

by Phil Salyers
Region V, National Hwy. Traffic Safety Administration
Publ: HS-019 382, Pedestrian Safety. Seminar, St. Cloud, 1975
p1-5
1975
Summary of HS-801 413. Seminar held 24-25 Apr 1975.
Availability: In HS-019 382

HS-019 384

HOW SAFE IS WALKING?

Safety aspects of walking are reviewed from the point of view of the pedestrian and association with factors which are found involved in automobile-pedestrian collisions. Pedestrians are considered as an integral part of the highway transportation system, characterized as less predictable than drivers and more difficult to promote to safe and orderly movement. Difficulties with regulating pedestrian actions arise from the facts that: many pedestrians consider themselves outside the law in traffic matters; pedestrian regulations are not frequently stressed by law enforcement; pedestrians are generally reluctant to voluntarily use special facilities provided for safety reasons; and many pedestrians are not familiar with traffic laws. Safety equipment and facilities which have been designed and installed for pedestrian use include urban speed limits for vehicular traffic, traffic signals to allow for pedestrian crossing, automotive safety designs (such as bumper positions and materials), reflectorized clothing, revised urban planning, and pedestrian shelters and walkways. Factors which are involved in automobile-pedestrian collisions include age, alcohol, environment, and pedestrian actions. The majority of pedestrian accidents involve children or aged persons, alcohol involvement in the young and middle-aged pedestrian group (especially males), urban areas for more accidents and rural areas for more fatalities, and pedestrian actions between intersections without benefit of crossing lanes, signals, or special pedestrian facilities. Children may ignore the pedestrian facilities provided and other users may ignore and/or misuse them, resulting in avoidable accidents. The factor of suicide also cannot be discounted in pedestrian accidents. Further studies on an individual case basis are recommended to accumulate meaningful data as a means of designing and using roads with the safety of both drivers and pedestrians as an objective.

by William E. Marsden, Jr.
St. Cloud State Univ., Minnesota Hwy. Safety Center, St. Cloud, Minn. 56301
Publ: HS-019 382, Pedestrian Safety. Seminar, St. Cloud, 1975
p6-12
1975
Availability: In HS-019 382

HS-019 385

PUPIL TRANSPORTATION SAFETY

Problems of pupil transportation safety in the pedestrian mode (public awareness, driver awareness, and routing) are described and possible solutions are suggested. A pupil may be considered a pedestrian once he steps off the school bus. In this situation the pupil is susceptible to the motoring public's reluctance, refusal, or ignorance of the school bus stop law in terms of personal safety. Many techniques (posters, television, radio announcements, and newspaper articles) have been utilized in a public education campaign to inform motorists of the bus stop law. In some regions the education campaign has been successful, but a substantial rate of violation of passing a stopped school bus continues. Possible solutions to the problem of educating and enforcing the school bus stop law include increased enforcement; increased publicity via mass media; assigning responsibility to the school bus driver to stop traffic around the school bus; and education of the school bus passenger in the proper survival techniques of being a pedestrian. Limitations of increased enforcement are the additional burden placed on police and the court system for minimal returns. The publicity campaign is considered ongoing and continual in conjunction with other approaches to the problem. The feasibility of assigning additional tasks to the school bus driver seems good also. The technique of educating school bus riders is considered the ultimate alternative. Although children are impulsive by nature, it is believed that with constant training and reminders they could be made more cognizant of the need to observe traffic conditions before crossing the roadway after leaving the school bus. Educative materials for the children could be provided by means of the

driver, school, parents, commercial training packages, or combinations of these. Driver awareness is a function of attentiveness and control of student actions. Drivers can be taught proper backing procedures, cornering techniques, and awareness behavior with control techniques for assembling, counting, and monitoring student access to and from the bus. The problem of routing may be approached by considering input from drivers, parents, and students in administrative decisions for routing and scheduled bus stops, so that the safest feasible transportation system is provided.

by Rodney G. Dobey
St. Cloud State Univ., Minnesota Hwy. Safety Center,
St.Cloud, Minn. 56301
Publ: HS-019 382, Pedestrian Safety. Seminar, St. Cloud, 1975
p13-6
1975
Availability: In HS-019 382

HS-019 386

SCHOOL PEDESTRIAN SAFETY

An adversary position for promoting and enforcing school pedestrian safety is introduced, citing the responsibility of administrators and planners to provide pedestrian safety facilities and policies in the face of public ignorance, emotion, and noninvolvement. The traditional approach to school pedestrian safety has incorporated engineering, education, and enforcement measures. The combination of these measures has been proven less than totally effective, and some new problems in school pedestrian safety have been created. Some suggestions to improve pedestrian safety include: crossing warrants, angled parking to prevent dart-out behavior, engineering planning and construction, mass media education materials, behavioral modification through traffic controls and enforcement, and accommodation of probable behaviors. Another significant measure suggested as a means of combatting school pedestrian accidents is direct contact with and education of parents with school-aged children. Parents can operate in two ways to impose pedestrian safety: teach self-reliance and pedestrian survival techniques to their own children in their customary and necessary environments, and take responsibility for preventing pedestrian hazards both in their own actions and in monitoring others' actions. One way in which parents can both teach and be responsible for their children in pedestrian safety is in advocacy for practical and useful pedestrian controls and protective devices. Treating parents like students in order to get their cooperation and influence in teaching their children the facts of pedestrian safety is suggested as a first step in achieving a better safety record. Reaching the parents is suggested by such measures as news media, parent-teacher associations, teacher communication with parents about their own children's pedestrian behavior, demonstrating pedestrian accident results to parents to motivate their cooperation, holding a pedestrian education day, involving the parents in planning school routes and pedestrian facilities, and contacting parents for help in collecting data for pedestrian-related engineering studies.

by A. Powell Harrison
County of San Diego, San Diego, Calif.
Publ: HS-019 382, Pedestrian Safety. Seminar, St. Cloud, 1975
p17-29
1975
Seminar held 24-25 Apr 1975.
Availability: In HS-019 382

HS-019 387

PEDESTRIAN SAFETY. ALCOHOL AND PEDESTRIAN SAFETY

Information on alcohol relation to pedestrian safety is reviewed in legislation, controlled studies, and statistical data, demonstrating that the problem has been largely ignored or uninterpreted. On the whole responsibility for the safety of drinking pedestrians has been placed with drivers. Drivers have been consistently warned in vehicle codes, traffic ordinances, and policy statements that the pedestrian has the ultimate right-of-way and that accidents with the pedestrian in whatever behavior or state he/she may be are the liability of the driver. Reported percentages of drinking or intoxicated pedestrians have been scarcely obtainable, but where available it is believed that they underestimate the true extent of the problem. As establishment of chemical standards for the legal interpretation of "under the influence of alcohol" in terms of concentration of alcohol in the blood of its equivalent in other body materials was accomplished, data gathered on accident victims revealed more alcohol involvement than was previously documented. When the extent of the problem was surveyed, three attempt categories were initially used to approach the situation: legislation specifically directed at drinking pedestrians, public education, and enforcement. These measures have been little used in the problem area, with primary emphasis given rather to drinking drivers. A new program of concern and action relating to the drinking pedestrian problem is proposed including: identification of the problem, conflict reduction between motor vehicles and pedestrians, driver familiarization regarding pedestrian safety, public education and training in pedestrian safety, enforcement and surveillance of the drinking pedestrian, and counseling and rehabilitation of the drinking pedestrian. Measures which are advocated for use in the program include health and medical services, decriminalization of offenses, social services, pedestrian protection facilities, better road lighting, land-use planning and regulation, adequate parking facilities and implementation, traffic engineering, driver education, and safety association involvement.

by Elbert Hugunin
National Safety Council
Publ: HS-019 382, Pedestrian Safety. Seminar, St. Cloud, 1975
p30-51
1975
Availability: In HS-019 382

HS-019 388

DRIVEABILITY PERFORMANCE OF 1975 PASSENGER CARS AT INTERMEDIATE AMBIENT TEMPERATURES

The objective of the driveability program is to determine the relationship between fuel volatility and vehicle driveability of selected 1975 California model cars. This report presents an analysis of the intermediate ambient temperature (40-70° F) portion of a two-part program, the other being a measure of driveability at high ambient temperatures (90-100° F). For 1975 model cars, driveability demerits at intermediate temperatures decreased as fuel volatility increased. The 50% distillation point had the greatest effect on driveability performance. An independent relationship between fuel volatility and driveability of the 1975 test cars could not be established because two of the fuels were abnormal (containing large amounts of benzene) in several properties other than 10, 50, and 90%

distillation points. It is believed that one or more abnormal properties adversely affected driveability. The fuel volatility-driveability relationship is: driveability demerits 0 0.62 (10% evap. temp.) 0 0.85 (50% evap. temp.) 0 0.47 (90% evap. temp.) - 286. There were large variations in driveability demerits between individual cars. There were large variations in individual car responses to fuel volatility. Thirteen of 31 cars did not distinguish between the most volatile and least volatile fuels. A 10° F increase in ambient temperature decreased Total Weighted Demerits (TWD) about 4%. A 10° F increase in overnight soak temperature decreased TWD about 6%. Six tables, thirteen figures and five appendices cover such data as test fuel inspection figures, test fuel hydrocarbon type analysis, description of test cars, fuel design for variation in distillation temperatures, intermediate temperature driveability road course, the 1974 intermediate temperature program, list of participants in the 1974 driveability test and membership of working panels, and the test results.

Coordinating Res. Council, Inc., 1974 Analysis and Report Writing Panel, 30 Rockefeller Plaza, New York, N.Y. 10020
Rept. No. CRC-486; 1976; 77p 2refs
CRC Proj. CM-102-74.
Availability: Corporate author

HS-019 389

AGES OF DRIVERS INVOLVED IN SOME JUNCTION ACCIDENTS

The intersections studied include samples of those controlled by traffic signals in outer London, urban major/minor intersections with different speed limits, and rural major/minor intersections. In particular, ages of drivers approaching on the major and minor roads were examined. In general, accident involvement at intersections related to the amount of car travel was above average for the under 25 age group and for those of 65 years and over. At major/minor intersections there was a marked trend for accident involvement to increase with age on the minor road approaches in rural areas. Older drivers were also more at risk though to a lesser extent on the minor road approaches in urban areas subject to speed limits of 30 or 40 mph. The age factor was most marked for divided highways and the difficulties older drivers experience seem to be associated with restarting after a stop at a major road. Included are four tables showing the ages of the drivers involved in accidents at intersections by area and by road type, by time of day, as well as data on accidents at T intersections, Y intersections and at roundabouts (traffic circles).

by C. R. Faulkner
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. TRRL-SR131UC ; 1975; 14p 5refs
Availability: Corporate author

HS-019 390

THE DRIVING SITUATIONS WHICH WORRY MOTORISTS

To understand driver fears and recommend relevant training, a study was undertaken of situations that worry drivers. 852 motorists were asked how much they would worry if they had to drive in particular situations. The results showed that many drivers were worried about interstate highway driving in bad weather conditions. Many drivers think they could be involved in an accident, and that cars will catch fire or turn over if an accident occurs. Women drivers and new drivers are more likely to worry than others. Those who have experienced hazardous situations worry less about confronting them than those who have not. Consequently, training techniques must be adopted to provide experience with hazardous conditions as close to real as possible. Books, slides, films, or demonstration drives could provide information in coping with hazardous driving conditions. Included are tables showing drivers' opinions on driving conditions and the degree of worry attached to the particular situation, opinions on accident likelihood and consequences, driving experience, relationships between driving conditions and experience, between driving conditions and driver characteristics, and between experience and characteristics. An appendix explains the sampling used in the study.

by D. Sheppard
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. TRRL-SR-129UC ; 1975; 22p 10refs
Availability: Corporate author

HS-019 391

A HISTORY OF THE AUTOMOTIVE INTERNAL COMBUSTION ENGINE

Four articles are presented which represent the various phases of technical development in the history of the automotive internal combustion engine. Subjects which are reviewed include: early internal combustion and automotive engines; the automobile engine from 1920 to 1950; the current developments in spark-ignition engines; and the future of automotive power plants. The early history of the internal combustion engine is characterized by the variety of approaches and the lack of external constraints placed on them. The second phase of the engine's development witnessed the beginning of large scale production, a rapid development, and a consolidation of technology. The third and fourth phases, which cover the last two decades, brought in, successively, the impacts of technological advance accelerated by the second world war, the emergence of the large scale automotive industry outside the U.S., the awareness and the demand for environmental control resulting from over congestion of automobiles in large cities, and the painful realization of the dwindling natural petroleum resources brought into focus by the oil embargo.

Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pa. 15096
Rept. No. SAE-SP-409; 1976; 60p 52refs
Includes HS-019 392--HS-019 395. Prepared for Presentation at the SAE West Coast Meeting, San Francisco, 9-12 Aug 1976.
Availability: SAE

HS-019 392

EARLY IC ,INTERNAL COMBUSTION0 AND AUTOMOTIVE ENGINES

Selected pre-1900 internal combustion engines and the automotive engines of the 1900-1920 era are described briefly. The pre-1900 list includes the atmospheric, non-compression, Brayton, and Otto four-stroke cycle engines. Performance data and pressure/volume diagrams of the various types are given. In the early 1900's, automobiles changed from being toys for the wealthy to providing transportation for the masses. Many

limitations and difficulties were imposed by available fuels, deficiencies in ignition, carburetion, and combustion chamber design. These problems were partially overcome through the efforts of such early engine pioneers as: John Barber, who, in 1971, accurately outlined all the elements of both a geared gas turbine and a pure reaction jet; Phillipe Lebon, who described a double-acting gas engine with external gas and air supply pumps; Issac de Rivaz, who built a manually controlled atmospheric gas engine that was tested in a vehicle on Swiss Alpine roads; J. J. Lenoir, who developed the noncompression gas engine; N. A. Otto and Eugen Langen who developed the atmospheric engine; and Karl Benz, who helped to develop the two stroke engine. In the early years, there was a complete lack of interagency standards. In 1905, the Society of Automotive Engineers (SAE) was formed which made significant contributions through its standards committees and information interchange of technical papers. One of the major SAE concerns was how to devise standard means of comparing automobile performance in terms of fuel consumption and acceleration. Short overviews of the development of ignition systems, lubrication systems, and vehicle performance are given. By 1920, the philosophy of automotive engine design was established.

by C. Lyle Cummins, Jr.
Carnot Press
Publ: HS-019 391 (SP-409), A History of the Automotive Internal Combustion Engine, Warrendale, 1976, p1-12
Rept. No. SAE-760604; 1976; 20refs
Prepared for presentation at the SAE West Coast Meeting, San Francisco, 9-12 Aug 1976.
Availability: In HS-019 391

HS-019 393

THE AUTOMOBILE ENGINE 1920-1950

The development of the automobile engine is surveyed from 1920-1950, the beginning of commercial production to the present. American and European practices are reviewed. In particular, the relation of fuel quality to engine design is emphasized as an important factor. Almost all components, fuels, and lubricants underwent profound changes. The number of vehicles produced in the U.S. rose one and one half million in 1922 to six and one half million in 1950. In Europe, the car's status changed from that of an enthusiast's toy to a way of life more resembling that of America but retaining a technical diversity of design and size that was unmatched in the U.S. Further changes, produced by large improvements in fuel octane rating, were only just beginning at the end of the period and were not fully implemented. Specific power outputs doubled and durability, especially in Europe, greatly increased. Material improvements for valves, piston rings, and bearings accounted for much of this, but better oils and thermostatic cooling control also played a part. Many features of the engines of the end of the period could be seen at much earlier dates but were often combined with others which led to failure or were sponsored by companies with inadequate resources. As the size of producers grew, their research and development facilities expanded and more controlled test programs solved problems in a shorter time than would have been possible earlier. The influence of societies such as the Society of Automotive Engineers (SAE) in America and the British IAE was marked.

by J. G. G. Hempson
Ricardo and Co., Ltd. (United Kingdom)
Publ: HS-019 391 (SP-409), A History of the Automotive Internal Combustion Engine, Warrendale, 1976, p13-26
Rept. No. SAE-760605; 1976; 3refs
Prepared for presentation at the SAE West Coast Meeting, San Francisco, 9-12 Aug 1976.
Availability: In HS-019 391

HS-019 394

CURRENT DEVELOPMENTS IN SPARK-IGNITION ENGINES

The major changes that have occurred in spark ignition engine design and operation over the last two decades are reviewed. The automobile air pollution problem, which includes automobile emission and fuel economy standards is described briefly, together with the mechanisms causing pollution in spark-ignition engines. The major components in spark-ignition engine emission control systems are outlined, and advances in carburetion, fuel injection, ignition systems, spark retard and exhaust gas recycle strategies, and catalytic converters, are reviewed. The impact of these emission controls on vehicle fuel economy is assessed. The recent substantial rise in gasoline price and the increase in public awareness of fuel economy as an important vehicle attribute, have focussed renewed attention on engine efficiency. Improvements are already being realized; a comparison of engine/displacement/vehicle inertia weight combinations available in both 1975 and 1976 shows an average 8.8% improvement in fuel economy due to system optimization. The contributing factors of greatest importance are: emission control system design and engine calibration changes; engine design improvements (e.g., fuel injection, quick-heat intake systems, modified valve timing); transmission design or shift scheduling changes; and axle ratio changes. Finally, the operating characteristics of alternative spark-ignition engines--the Wankel and several stratified charge engines--which are competing with the conventional engine, are discussed briefly. Illustrations presented include: a schematic showing how the three major pollutants--HC, CO and NOx--form inside the engine cylinder; a table showing a summary of automobile urban air pollution problems; a typical engine control system for the reduction of exhaust emissions; a schematic of the Chrysler lean-burn engine system; and the Carter altitude compensation system.

by John B. Heywood; Rodney J. Tabaczyniski
Massachusetts Inst. of Tech., Sloan Automotive Lab.
Publ: HS-019 391 (SP-409), A History of the Automotive Internal Combustion Engine, Warrendale, 1976, p27-45
Rept. No. SAE-760606; 1976; 29refs
Prepared for presentation at the SAE West Coast Meeting, San Francisco, 9-12 Aug 1976.
Availability: In HS-019 391

HS-019 395

FUTURE AUTOMOTIVE POWER PLANTS

The background against which future powerplant selection must be made is contemplated. Emissions control and fuel economy are the major forces behind the search for alternative power plants. There continue to be major developments in the spark-ignition power plant, but we are turning elsewhere

for a better trade-off between emissions, fuel availability, fuel economy, reliability, and cost. Alternate automotive propulsion systems are classified in four groups: external combustion engines (the Rankine or steam engine and the Stirling engine are the important engines in this class); electrochemical systems which avoid on-board combustion of fuel (battery and fuel cell systems are mentioned); a hybrid which is anything of mixed origin--a combination in which a heat engine converts the fuel to mechanical energy that drives the vehicle directly or is stored in an electric battery or flywheel; and the internal combustion engine in the recent development of which the fuel is burned in the working fluid. Because the spark-ignition piston engine is in this category it is the most common form of automotive prime mover (stratified charge, diesel, and gas turbine are included in this category). Because fuel types have profound effects on engine behavior, some are listed. The broad cut petroleum is of particular interest for some stratified charge engines, Stirlings, gas turbines, and certain diesel engines. Hydrogen can function in any of the four power plant categories either as a fuel to be burned or as the on-board energy source for a fuel cell. Given the successful development of an economical, light-weight, high-energy battery, it is predicted that electric cars have the potential for low operating cost, clean power conversion, and the convenience of dual mode operation, in which the vehicle can operate independently, or as part of an integrated transit system. The electric car which is attractive today might be irresistible by the year 2000.

by George J. Huebner, Jr.
Publ: HS-019 391 (SP-409), A History of the Automotive Internal Combustion Engine, Warrendale, 1976, p47-56
Rept. No. SAE-760607; 1976
Prepared for presentation at the SAE West Coast Meeting, San Francisco, 9-12 Aug 1976.
Availability: In HS-019 391

HS-019 396

INSTRUCTIONS TO DRIVERS TO MAINTAIN SAFE SPACINGS BETWEEN FOLLOWING VEHICLES

An experiment is described which measured drivers' accuracy in carrying out different instructions about spacing between following vehicles. A third of the subjects felt that the existing Highway Code recommendation of 1 yard per 1 mph (just over 2 seconds) was too great. Thus there is a need to convince drivers that such spacings are necessary for road safety. Attempting to follow 2 seconds behind another vehicle by selecting a distance which enabled the phrase "keep a safe distance, keep a safe distance" to be said in the interval between following vehicles, was found to be the most consistent instruction. Nevertheless, at 30 and 40 mph, up to one sixth of drivers followed at less than 1 second. For practical use it would be desirable to increase the target mean time. Other instructions caused drivers to follow at greater intervals but there were much wider variations in the choices made, and it is unlikely that the much greater distances chosen by some drivers would be maintained on the road.

by A. M. Mackie; K. Russam
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. TRRL-SR-166UC ; 1975; 18p 2refs
Availability: Corporate author

HS-019 397

DECISION PROCESSES IN DRIVING

The concept of "decision" is discussed along with its application to the actions of a driver. Accidents occur because of insufficient information, or incorrect use of information. Driving decisions are courses of action chosen from alternatives, which require cognitive effort and are not automatic. A driving decision is "any decision process that directs driver activities that are critical in maintaining the intentions of the journey." Psychological research is not readily applicable to driver decision making, but gives some basis for approaching the problem. Concepts potentially useful include information flow and information processing, information feedback, utility value, and signal-detection concepts of sensitivity and criterion. Using information processing techniques a model of driver decision making processes should provide: a conceptualization of the decision mechanisms and their functions relating to components of the decision, and a rationale for making predictions that are amenable to experimental test. Specific data on information feedback in the driver situation is not available, although a suggestion has been made that skill breakdown, particularly in old age, is due to deterioration of feedback processes. Decision processing time is affected by complexity of choice and is increased when all choices are unattractive. Psychological refractory period is a phenomenon generated by the coincidence of too many decisions at the same time. After a decision overload a "hysteresis" effect can decrease efficiency for some time particularly in aged, drugged or intoxicated subjects. Viewing the driver as an information processor may or may not be helpful in analyzing driver behavior, as the driver acts both actively and passively in response to stimuli from ambient conditions, roadside signs and vehicle instruments. Decisions are broken down in driving when inappropriate information is used, information is used wrongly, or the driver lacks skill in performing the correct decision. Inflexibility of old age or long experience is a breakdown factor that must be considered when planning changes to roadways and traffic rules. Research techniques to study the driver's decision-making process include, using observers, film, or video tape recording (VTR), but there are disadvantages to these techniques. Instrumentation to remove subjectivity includes psychogalvanic skin response and electrocardiographs, but it seems unlikely that the use of these instruments will be successful. A method for measuring the mental load of a task by measuring a subject's ability to perform additional tasks is known as the spare capacity method, and this method may be useful in yielding data. A subsidiary subtask method of determining the demand being made by a primary task appears to offer the best method of investigating driver decisions.

by L. R. Newsome
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. TRRL-SR-156UC ; 1975; 27p 39refs
Availability: Corporate author

HS-019 398

ADMINISTRATIVE ADJUDICATION OF TRAFFIC OFFENSES IN CALIFORNIA. A FEASIBILITY STUDY. SUMMARY.

Department of Motor Vehicles, Sacramento, Calif.
Rept. No. PB-254 732; 1976; 23p
For abstract, see HS-019 399. For appendixes, see HS-019 400.
Availability: NTIS

HS-019 399

ADMINISTRATIVE ADJUDICATION OF TRAFFIC OFFENSES IN CALIFORNIA. A FEASIBILITY STUDY VOL. 1

Analysis of the feasibility of adjudicating traffic infractions administratively in California was mandated by Senate Concurrent Resolution 40, in 1975. At present traffic offenses are classified as crimes and handled by the court system; conviction fines range between $50 and $250. Administrative adjudication would decriminalize these infractions and remove the cases from the courts. Traffic safety oriented sanctions would be imposed. Uniformity and consistency would be provided statewide, and any person could represent himself or herself. Savings of $19 million are estimated in the first year, with increased savings due to increased service levels, and enhanced detection. After initial start-up the cost would be $12 million a year. The proposed system appears to be economically feasible, and meets both Federal and State constitutional requirements. Public attitude is likely to be favorable, the judicial system would be relieved, and traffic safety improved. A pilot study to obtain precise data is recommended. The feasibility study was conducted by a five-member task force, who travelled to several states to observe practical aspects of administrative adjudication. In Washington, D.C., discussions took place with representatives of the Department of Transportation, NHTSA, Department of Justice, and Law Enforcement Assistance Administration (LEAA). In-depth legal analysis was researched, and courts and police agencies throughout California were visited. In general, individuals, groups, and agencies at Federal and State levels favor the implementation of a simplified system for the adjudication of minor traffic offenses. The California Model of Administrative Adjudication was developed, including all traffic infractions except parking. A five-member administrative adjudication board would administer the program and hear appeals. Juveniles between 16 and 18 would be included. Areas of administration, organization, and operations were developed, the State being divided into two regions of three and six areas. Area processing centers would update files and process mail. Revenue would be distributed as at present. Some counties and cities may be adversely affected if they retain only a fixed 24% of the revenue. The adjudication of traffic offenses would not constitute the exercise of judicial power, and the authority of a hearing officer in the suspension or revocation of a license appears similar to that of professional licensing boards. There appear to be no constitutional impediments to the California Model. In all population areas public opinion showed a favorable response, from 71% to 77%. Further questions focused on public attitudes toward the courts, the motorist defendant, the police, and the Department of Motor Vehicles.

Department of Motor Vehicles, Sacramento, Calif.
Rept. No. PB-254 733; 1976; 208p 42refs
For summary report, see HS-019 398. For appendixes, see HS-019 400.
Availability: NTIS

HS-019 400

ADMINISTRATIVE ADJUDICATION OF TRAFFIC OFFENSES IN CALIFORNIA. A FEASIBILITY STUDY. VOL. 2

The appendixes contain the following information: the final report of a special ad hoc task force, appointed by the National Highway Safety Advisory Committee, which investigate traditional and innovative adjudication; Federal standards o traffic offense adjudication and a memo on proposed revisio in the handling of minor traffic violations in California; th legal analysis of the California model for administrative adj dication; disposition of fines and forfeitures; the summary of driver improvement program effectiveness; a department finance evaluation of the weighted caseload technique and tri court costs; opinion survey instruments; a model enablir legislation for administrative adjudication with cost details ar projections; Senate Resolution No. 160; and Senate Concu rent Resolution No. 40.

Department of Motor Vehicles, Sacramento, Calif.
Rept. No. PB-254 734; 1976; 256p 391refs
For summary, see HS-019 398. For text, see Vol. 1, HS-019 399.
Availability: NTIS

HS-019 401

INSTRUMENTED VEHICLE RESEARCH ON HIGHWAY INFORMATION SYSTEMS

A methodological approach for the study of highway signin In-vehicle Sign Simulation (ISS), has been developed with the Federal Highway Administration. The ISS method requir an instrumented automobile to measure motorists' respons to experimental signs presented on a screen inside the vehic With the ISS method, subjects are tested while driving highways open to normal traffic operations, an improveme over artificial laboratory conditions or poorly controlled fie environments for studying new information systems. The IS method bridges the gap between these two approaches providing the rigorous experimental control typical of t laboratory in the realism of the actual driving environment a situation. The research variables that can be studied with t ISS method are: display types (variable versus fixed messag message function (guide versus regulatory), message conte (graphic versus printed legend), message format, messa placement, message redundancy, message modality (audito versus visual), message legibility and intelligibility, pre-t planning, and navigational aids. Interactions of these variabl with highway geometrics, other highway design features, a driver variables such as route familiarity and driving e perience can also be studied. Measures used to study the variables include information interpretation time, route choi decisions, vehicular control (speed and steering control), p formance on memory tasks, and psychophysiological and su jective responses. Disadvantages encountered in use of t ISS method include small sample sizes, visual problems aged drivers which conflict with evaluation requirements, a expense and specialization of equipment and research pers nel. It is concluded that the user information system aspect the ISS method is valuable in evaluating and planning for n torists' signing needs.

by Truman M. Mast; James A. Ballas; Joseph I. Peters
Publ: Public Roads v40 n2 p53-9 (Sep 1976)
1976; 6refs
Availability: See publication

HS-019 402

DESIGNING AN INSTRUMENTED DRIVER RESPONSE SYSTEM

An overview of nontechnical and technical considerations is presented for designing a vehicle driver-response instrumentation system which measures driver response to audio and visual stimuli. Nontechnical considerations included users' needs and preferences, contractual commitments, safety design, realistic driving environment and logistics, sound and heat insulation for driver comfort and safety, communications equipment provision, and operation with a minimum of concentration beyond that required for normal driving. Technical design considerations related system configuration to system requirements. Configurations studied for inclusion were analog or digital instrumentation, computer equipment, and monitoring equipment. A decision was reached to implement a computer-compatible digital system, with instantaneous printout of data identical to that being recorded in the system on magnetic tape. In this way the operation of all equipment in the system as well as experimental data could be monitored in real time, aiding diagnosis of tape errors or computer processing problems. Users of the instrumented vehicle specified the following parameters for measurement and recording once per second: vehicle velocity, distance traveled from arbitrary start point, latency of subject response, steering-wheel position, accelerator position, steering-wheel reversals, accelerator reversals, brake applications, event codes, and time from beginning of an experimental run. The system operates by the experimenter pressing an appropriate button to present a visual or audio stimulus to the experimental subject. Visual stimuli are presented by a remote-controlled projector having an 80-slide magazine, while audio stimuli are presented as verbal instructions to the subject through the vehicle's radio loudspeaker. The experimental subject is able to halt the stimuli by an appropriate reaction. Five different recording instruments are used to allow the experimenter to precisely review location, traffic, weather, road conditions, and other factors existing during the experiment, including a computer-compatible, nine-channel, reel-to-reel incremental digital magnetic tape recorder; a 20-column printer; an audio voice recorder; and two 16mm cameras mounted behind the front seat. Other design considerations included power requirements and supply, the electrical grounding system, transducers, latency measurement, and steering wheel and accelerator positions and brake applications detectors. After the equipment designed was built, it was tested in an electronics laboratory (faulty components and errors in logic and wiring were corrected), then installed in the test vehicle. The only difficulty experienced during tests was electrical transient pickup from such events as opening a door (light switch) or operating the turn signals, horn, and other accessories. Bypassing this equipment with capacitors and diodes overcame these difficulties. A detailed instruction manual for operating the system was prepared, and informal training sessions were held for personnel who were to operate the equipment. The equipment has been virtually maintenance-free, with users reporting a loss of only 10 seconds of data after testing 60 subjects for a period of 0.5 hour each. It is concluded that the design of the instrumented driver response system is satisfactory.

by Joseph C. Leifer
Publ: Public Roads v40 n2 p60-5 (Sep 1976)
1976
Availability: See publication

HS-019 403

BENEFIT-RISK ANALYSIS IN THE DESIGN OF HIGHWAY STREAM CROSSINGS

A large-scale research effort to study and simulate backwater and its resultant damages associated with the design of highway stream crossings is reported. In particular a process of benefit-risk analysis is described to prevent costly overdesign as a direct result of considering one design factor at the expense of others. The relationship in the benefit-risk system is defined as the highway's ability to pass a given design flood as related to both additional investment in initial construction for an event with a low probability of occurrence and increased damage repair and maintenance costs in maintaining a highway in the event of floods of sizes of increased probability. The benefit-risk method provides a means of evaluating total costs of alternative designs, weighting those costs associated with probable events by the event's chance of occurrence. Various combinations of structure, their sizes, their initial costs, and their expected flood damage costs are analyzed. Results of the analysis can then be used to allocate funds for highway stream crossing construction, using hydrologic information and probabilities of flood occurrence and by evaluating economic response to imposed hydraulic conditions. The method has been illustrated in the analysis of a highway stream crossing near Tallahalla, Miss. The example analysis is based on representative hydrologic, hydraulic, and traffic data for the site, and on construction costs averaged from a large number of bridges. The risk model was run for several alternate designs including the existing bridge design, modifying bridge lengths and embankment elevations. The optimal design configuration among those modeled was selected as a bridge length of 300 ft (91 m) with an embankment elevation of 315 ft (96 m), costing $20,000 per year less than the existing bridge configuration. Benefit-risk analysis has also been applied to the optimum design of box culverts, using 22 test sites largely in rural settings. These analyses indicated that optimum design would usually have resulted in structures smaller than those actually constructed. Opposite findings may be anticipated for some urban sites due to the high risks associated with highly developed properties and heavier traffic flows. It is concluded that the benefit-risk analysis method provides an optimal solution to the problem of handling backwater configurations caused by highway crossings.

by Anthony J. Knepp; Ming T. Tseng; J. Sterling Jones
Publ: Public Roads v40 n2 p66-9 (Sep 1976)
1976; 7refs
Availability: See publication

HS-019 404

ANALYSIS AND REMEDIES OF FREEWAY TRAFFIC DISTURBANCES

The planning, design, and operation of traffic-responsive incident management systems, and the development of guidelines for detecting, locating, and clearing freeway incidents rapidly are subjects of the project. It is estimated that, in the U.S., motorists lose 750 million vehicle hours per year waiting for freeway incidents to be cleared, resulting in an annual waste of approximately 400 million gallons of fuel. Approximately half of the delay on urban freeways is caused by unexpected incidents such as spilled loads, collisions, and stalled vehicles. Of approximately two million accidents reported each year on urban freeways, 41,000 are caused by vehicles already in the roadway and nearly 11% of the ac-

cidents involve chain collisions. Research has shown that the loss of a freeway lane because of blockage results in traffic flow loss in more than one lane, reducing traffic flow in three-lane or four-lane highway sections by 50% and 33%, respectively. Disabled or stopped vehicles also cause freeway lane blockages, with one stop/18,000 vehicle miles for reasons such as map reading, mechanical problems, and driver desire, and one stop/26,000 vehicle miles due to mechanical breakdowns, followed principally by flat tires, fuel depletion, overheating, and electrical system malfunction. Some form of freeway surveillance is needed to combat the expensive and dangerous delays these blockages cause. This may be provided by loop detectors, police, telephone, call boxes, service patrols, or citizens' band radios. Once an incident has been detected and confirmed, some form of incident management strategy can be employed; the corrective measure depending on the type and seriousness of the incident and the kind of controls available for maintaining freeway flow. Typically, the incident is removed and where surveillance and control systems are in operation, restrictive ramp metering or route diversion may be used with the objective of restoring the freeway to normal operations as soon as possible. To minimize delay and disruption of traffic, incident management strategies can make use of preplanned, stand-by procedures. Individual studies which are being carried out to enable stable traffic flow conditions on freeways and to minimize the effects of freeway incidents include: freeway traffic modeling, freeway control experimentation (evaluation of remedial concepts, development of software and hardware specifications for implementing concepts, and experimental test of concepts in the field), development of strategies and criteria for their use, and human factors analysis and design. Major achievements to date have been in the expansion or implementation of surveillance and control systems which incorporate incident detection, preplanned incident management methods, and off-freeway accident investigation sites. Surveillance projects are currently in effect in Illinois, California, Texas, Minnesota, Ohio and Colorado. In some locations, such projects are credited with freeway accident reductions of up to 50%.

by Samuel C. Tignor
Publ: Public Roads v40 n2 p70-7 (Sep 1976)
1976; 26refs
Availability: See publication

HS-019 405

THE USE OF SKEWED SPEED DISTRIBUTIONS TO LOCATE POINTS OF HIGH ACCIDENT POTENTIAL ON LOW VOLUME TWO-LANE RURAL HIGHWAYS. FINAL REPORT

In a study made of the use of skewed speed distributions to locate points of high accident potential on low volume two-lane rural highways, correlative relationships were sought by studying spot speeds and accident data from 12 sites during daytime hours and five sites during nighttime hours. A perception-speed concept of driver responses to a potential accident situation was developed. This concept examined a driver's reaction to a potential hazard based on his personal perception of the hazard and on the forces he had at his disposal to avoid the hazard. It was shown that where a driver had a particular difficulty in perceiving the hazard or where he perceived the hazard incorrectly, the probability of an accident occurring was greater, supporting the hypothesis made in development of the concept. It was also found that sites having high frequency distributions. Sites having low or no accident histories exhibited normal speed-frequency distributions. The comparison of the day and night data and directional data found that while certain parameters such as mean speed and deviation did change, the relative shape of the frequency distribution curve did not change if perceptual accuracy did not change. Research results indicate that the test and analysis procedure developed would be useful in finding areas of perceptual problems prior to the occurrence of accidents and to test the effectiveness of warning or corrective measures.

by R. J. Krzeminski
Purdue Univ., Joint Hwy. Res. Proj., West Lafayette, Ind.; Indiana State Highway Commission
Rept. No. JHRP-76-22 ; 1976; 96p 23refs
Availability: Corporate author
1975; 46p 13refs
Presented in summary form at NATO-CCMS Second Symposium on Low Pollution Power Systems Development, Dusseldorf, West Germany, 6 Nov 1974. Prepared for EPA/AAPSD (Alternative Automotive Power Systems Division), now part of ERDA.
Availability: NTIS

HS-019 407

ENERGY EQUIVALENTS FOR CURRENT AND PROSPECTIVE AUTOMOTIVE FUELS IN CANADA

Because of concern for limited energy resources, particularly petroleum, a specification has been developed for an energy conserving urban car which could use energy from sources other than existing automotive fuels. The energy equivalent study was found necessary to provide a basis for comparison of various current and prospective automotive energy sources. The majority of available data is based upon U.S. experience and does not accurately reflect Canadian conditions. To provide a common base from which to determine overall energy efficiencies, the calculations contained in the report are related to each source of primary fuel in situ. To arrive at the net fuel energy available to the consumer, an overall energy efficiency has been determined for each fuel from the individual efficiencies of the various production and distribution stages. Fuels studies include: gasoline, diesel fuel oil, liquefied petroleum gases, natural gas, methanol, processed coal, hydrogen, and electricity. Improved processes and/or process efficiencies may evolve, and some fuels may become unavailable for widespread automotive use, but they have been included for completeness and comparison. Economics, availability, and alternative uses must be taken into consideration, as well as energy efficiencies. Included are tables showing energy efficiencies for current and prospective automotive fuels in Canada, the Canadian energy balance for electricity and the energy equivalents for current and prospective automotive fuels in Canada, in addition to three appendices showing calculations of energy efficiencies at the present, for the year 1985, and for the year 2000.

by D. B. Conveney; M. J. Friend; G. M. Shulhan
National Res. Council of Canada, Div. of Mechanical Engineering, Ottawa
Rept. No. NRC-15233; MD-53; AD-A026 195; 1976; 55p 19refs
French summary.
Availability: NTIS

HS-019 408

HIGHWAY DESIGN FOR MOTOR VEHICLES--A HISTORICAL REVIEW. PART 7: THE EVOLUTION OF HIGHWAY GRADE DESIGN

The systematic study of road grades began in the early 19th century, coincident with the surfacing with stone of the principal roads in Europe and England. It was discovered that the traction required to pull a vehicle on a road depended on the road surface, the diameter of the wheel, the width of tire, and to a slight extent on the velocity of travel. Early studies of road grades in Scotland, England, and France were concerned with the tractive effort required by horses to draw a load. The tractive power of draft animals placed a limit on ascending gradients. The ideal maximum gradient was between 2.5 and 3%. In many U.S. states, 5 and 6% was allowed. Trucks and automobiles accommodated to these gradients well and were capable of better performance. Thus, in the 1920's road engineers sometimes used gradients as steep as 9% to maintain the trend to long tangents. There arose two schools of thought as to how the vertical alignment or profile should be designed in rolling country. The railroad school preferred long easy grades involving heavy cut and fill, and engineers of the rolling grade or humping school preferred to follow the ground profile. Sight distance on humping roads was a problem, particularly so as speeds increased. Since the 1930's the cost of earth-moving has been greatly reduced by mechanization and road design has returned to the railroad school of thought. Highway engineers of the 1920's were often trained as railroad engineers and carried the idea of grade compensation over into highway engineering so that by 1928 it was customary to compensate gradient on curves of less than 500 ft. radius. In 1939, the American Association of State Highway Officials adopted the design speed concept which provided engineers with a logical means of achieving consistent balanced design for horizontal alignments and vertical curvature. It took 23 years for the concept to become standard among the states. In 1919, Thomas R. Agg, one of the modern founders of highway engineering economy, proposed a method for solving location problems involving grades which took into account the inherent characteristics of the motor vehicle, especially its motive power. He prepared tables showing tractive effort at various gears and was able to compute the maximum gradient that the vehicle could surmount at full power in high gear without dropping below a minimum acceptable velocity (15 mph for trucks and 25 mph for autos). Agg's theory of grades was laborious in practice and was not widely used in highway design. In 1938 studies were made in an effort to increase truck speeds on gradients. The widening of roads at congested areas by adding climbing lanes was suggested. The 1938 study data were used for 1945 work on the effect of momentum. In Arizona (1949) and in Texas (1953), work was done to update knowledge on grade studies. In both procedures, the important factor for deciding when to use climbing lanes was the critical speed below which traffic operation became intolerable. By 1956, the states had reached agreement on maximum gradients for the interstate system. These were set at not more than 3, 4 and 5% for design speeds of 70, 60 and 50 mph, respectively. Gradients 2% steeper might be provided in rugged terrain. In 1961 consensus was reached on nonfreeway highway gradients. Included are graphs measuring the hill-climbing ability of motor trucks, the distance upgrade that momentum alone will carry vehicles, the effect of gross load on the speed of vehicles on a 4% grade, and speed patterns at various grades, from studies done in the 30's and 40's by the Public Roads Administration and the Arizona Highway Department.

by Frederick W. Cron
Publ: Public Roads v40 n2 p78-86 (Sep 1976)
1976; 18refs
Availability: See publication

HS-019 409

PEUGEOT--RENAULT--VOLVO 90° V6 ENGINE (6 x 88 x 73 - 2.664 cm3)

An advanced engine concept for a small size, reduced weight V6 power plant has been realized by cooperation of Peugeot, Renault, and Volvo corporations. Displacement of the engine is 2.66 liters; the cylinder block and cylinder head are made of aluminum. The V is 90° open so that the assembly assumes a compact and lightweight configuration. Fundamental elements considered for the choice of the structure of the engine assembly, particularly cylinder layout, are described, providing a technical analysis for the choice of: location of camshaft, drive of the distribution, sizes of bearings, structure of bearing caps, and structure of block reinforcing ribs. Performance criteria were to obtain the best balance with the best alternatives available, insuring proper engine aspiration, improved fuel distribution, and improved cylinder ignition. Particular attention was given to selection of a fuel injection and emission control system to meet applicable regulations. Overall advantages of the engine include provision of a broad rpm range and length and weight savings. The latter advantages can be used to reduce car length and/or to utilize an aluminum cylinder block. Factors which may be considered as disadvantageous include overall balance imperfections and cyclical regularity. Components of the engine selected for functional quality are: double overhead camshaft; oil pump speed and size to obtain an in-use output over 14 liters per 1000 engine rpm as soon as 600 crankshaft rpm is reached; single outlet water pump with stationary seal and belt drive at 1.10 times the speed of the crankshaft; conventional ignition (with an option for breakerless transistorized ignition or a fully electronic ignition system); carburetor fuel supply or fuel injection system; and emission control system impacting ignition, anti-evaporation system, exhaust gas recirculation, secondary air injection, and catalytic converter. Manufacture and use of the engine is currently in progress. Performance of the engine will enable the manufacturers to technically meet emission control regulations and to achieve performance specifications required by market and commercial policies. The engine production is termed economic and reasonably priced to the consumer because of utilization of advanced features and production methods.

by Francois Gastinne; M. Laliere; Stephen Wallman
Societe Anonyme des Automobiles Peugeot; Regie Nationale des Usines Renault; AB Volvo
Rept. No. SAE-760110; 1976; 20p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 410

A LOW VIBRATION ENGINE WITH UNIQUE COUNTER-BALANCE SHAFTS

A new in-line four-cylinder engine with its vibration reduced to a level comparable to the six-cylinder engine or rotary engine has been developed. It retains advantages over six-cylinder or eight-cylinder engines in production cost, engine size, weight, combustion efficiency, and emission control. The engine incorporates a unique balancing system which reduces the booming phenomena to a minimum in the vehicle passenger compartment, thus overcoming a previously inherent shortcoming of the four-cylinder engine in producing second order vibration in the vertical and rolling directions originating from reciprocating masses and explosions in the engine. The booming reduction was obtained by suitable selection of axial arrangement and direction of revolution of counter-balance shafts for equilibration of vertical forces only, reducing sharply the vibration presenting from the rolling moment due to inertia forces and explosion forces. Tests of the new engine have confirmed its expected improved vibration characteristics and endurance reliability. Noise evaluation of the engine in vehicle testing has shown that addition of the counter-balance shafts and driving apparatus has reduced vibration in the engine and its auxiliaries, resulting in reduced noise in the engine compartment as well as in the passenger compartment. Driveability of the vehicle furnished with the balanced engine was improved through noise reduction, enabling more comfortable increase in engine speed up to high speed to fully utilize engine performance capabilities. It is concluded that reduction of vibration in the engine will contribute to improve reliability of various emission control systems and components as well as various engine equipment.

by Hirokazu Nakamura
Mitsubishi Motors Corp., Japan
Rept. No. SAE-760111; 1976; 19p 6refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 411

IMPROVED PASSENGER CAR COOLING SYSTEMS

Techniques for reducing the power requirements for engine cooling are outlined. Power requirements related to cooling often come from the use of forced air convection through compact radiator matrices using ram air or electric fans. Means of reducing these requirements or fulfilling them more efficiently are available with improvements in radiators, fan installations, air circuit layout, and optimization of the air circuit power losses. These means have shown value not only in the design of passenger car cooling systems, but more significantly in the design of cooling systems for trucks, off-road, and armored fighting vehicles where confined space has incurred a greater proportion of the engine power to be required for cooling. Radiator design improvements related to more efficient cooling include: slimmer tubes, in-line arrangement of tubes, corrugation innovations (such as louvres), radiator tube pitch and thickness, and higher fin density. Fan installation improvements have been realized through the use of modified equipment driven off the engine crankshaft, redesign of ram air intake systems through aerodynamic parameters, composite fan and ram air systems with thermostatic controls, and fan redesign (blade width shape, cant, density, and composition). A preferred engine-cooling arrangement has emerged incorporating the advantageous improvements to obtain lowest power requirements and most effective cooling. The equipment matching the elements designated will vary in relative proportions, magnitude, and use in concert with other elements according to the individual vehicle design. Elements which may improve cooling efficiency and decrease power requirements for cooling in engines include: aerodynamic chin or spoiler to reduce drag and promote ram air flow from low level; efficient diffuser, adjustable to suit ambient conditions to minimize flow and drag; protective fine-mesh screen of high-percentage free area to promote better radiator performance because of the turbulence created in the airstream; condenser for air conditioning; radiator having close fin spacing and adequate face area and bulk volume; electrically-driven fans actuated by water thermostat and air conditioning compressor; and rearward-facing louvres at high level. These techniques, especially when applied to higher powered vehicles of various types, have produced improvements in fuel economy, noise level, and engine power usefully available for purposes other than cooling.

by S. P. Hawes
Research and Devel., Airscrew Howden Ltd.
Rept. No. SAE-760112; 1976; 10p 6refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 412

THE ATTITUDES AND PERCEPTIONS OF GROUPS ENGAGED IN THE PROVISION OF EMERGENCY MEDICAL SERVICES

Current methodologies for measuring performance and developing goals of public safety systems with respect to provision of emergency medical services (EMS) were investigated in a survey of attitudes and perceptions of groups engaged in EMS in Massachusetts. The objective of the survey was to identify divisions of opinion concerning EMS which might undermine current and future implementations of innovative EMS systems. Notions concerning regionalization and categorization of services, increased ambulance attendant training and responsibility, the incorporation of paramedics into the emergency department, physician and patient education, and alternative methods of paying for ambulance services were explored. A survey questionnaire was designed to examine relevant attitudes and perceptions and was distributed among physicians, hospital administrators, ambulance operators and attendants, health planners, interested citizens, public representatives, and other public agency operators in Massachusetts. There were 1,176 responses received and analyzed by the role each individual played in the EMS system. Findings indicate substantial agreement among the various groups on all issues, although it was clear from the responses to some questions that people are frequently uncertain as to the dimension of problems outside their own areas of interest or expertise. In addition, among the general consensus there were pools of resistance and disagreement, generally among those groups most closely involved with the issue in question. Such areas of discord were noted concerning the lack of training among ambulance attendants, the use of the emergency department by nonemergencies, and public confusion about the circumstances in which to use the emergency system. Three priorities were identified for new funding: increased training for ambulance attendants, acquisition of radio equipment to allow physician consultation on-scene and thereby to increase

the attendants' capabilities, and a program of public education. Strong support for the elements of a progressive EMS system was identified, relating to trained ambulance attendants capable of delivering stabilizing care at the scene of an emergency, phasing out of police emergency ambulance services, incorporation of triage and paramedical assistance in the emergency room, special emergency medical training for emergency physicians, education of patients in the use of the emergency system, increase in public financial responsibility for the provision of emergency ambulance service without eliminating patient contributions, and regionalization of ambulance services on a flexible basis. The economic bias in judgment on EMS elements was evident by analysis of the groups which registered resistance or dissatisfaction to some measures (e.g., public ambulance operators and attendants opposed regionalized ambulance service). These resistant comments on innovations which are being sponsored under the Emergency Medical Services Systems (EMSS) Act of 1973 will likely result in some modulation in the form of some EMSS Act requirements in order to ensure successful implementation.

by Keith A. Stevenson; Thomas R. Willemain
Massachusetts Inst. of Tech., Operations Res. Center, Cambridge, Mass. 02139
Grant NSF-GI38004
Rept. No. TR-11-74; 1974; 138p 27refs
Additional support from Department of Health, Education and Welfare Order No. PLD-7787-74.
Availability: Corporate author

HS-019 413

A SIMPLE PROCEDURE FOR THE ALLOCATION OF AMBULANCES IN SEMI-RURAL AREAS. TECHNICAL REPORT

The development of an emergency medical transportation plan for the four-county Bel-O-Mar region is described. A simple, flexible method was developed for the allocation of ambulances to a region under response time constraints. Data gathered from the Bel-O-Mar region of W. Va. in 1974 for 31 squads responding to calls from 90 communities are analyzed. The collection effort has yielded useful baseline data for general emergency medical service (EMS) planning. Data have been used to determine the minimum number of ambulances required to meet coverage type constraints as included in the Emergency Medical System Service (EMSS) Act guidelines; and the number of ambulances necessary to meet both political and coverage constraints. Two forms were used in the data collection effort, one to collect general information about squad activities, and one to collect specific data about 50 consecutive ambulance runs made by each squad. Data analysis revealed that 93% of all calls were classified as unscheduled and 99.5% of those were considered "emergent." The call rate for each area community was estimated. Various time intervals of importance in ambulance operations are shown together with their average values. The method used to determine the number and locations of ambulances to meet a set of coverage constraints for the Bel-O-Mar region is basically a degenerative version of the classical set-covering problem, and applies to rural and semirural areas having very little interaction among the vehicles. A simple, flexible "coverage-reduction" method is proposed for making allocations, and a set of allocations is presented which is based on various response time criteria and certain political constraints. The possibility of callers for ambulance service encountering a dispatch delay because all ambulances are busy at other calls is considered insignificant because demand rates in most parts of the Bel-O-Mar region are so small.

by James P. Jarvis; Keith A. Stevenson; Thomas R. Willemain
Massachusetts Inst. of Tech., Operations Res. Center, Cambridge, Mass. 02139
Grant NSF-GI38004
Rept. No. MIT-TR-13-75; 1975; 64p 5refs
Rept. on a research proj. titled "Innovative Resource Planning in Urban Public Safety Systems."
Availability: Corporate author

HS-019 414

COMPUTER PROGRAM FOR CALCULATING THE PERFORMANCE OF URBAN EMERGENCY SERVICE SYSTEMS: USER'S MANUAL (BATCH PROCESSING) PROGRAM VERSION 75-001 (BATCH). TECHNICAL REPORT

The use of the computer program, written in the PL/I language, that implements precise and approximate mathematical models for evaluating numerically certain performance characteristics of urban emergency service systems (police, emergency medical, and fire) is outlined. Model assumptions, data requirements, and outputs are briefly reviewed. The model can be used to estimate certain performance measures of any spatially distributed emergency service system, and represents a powerful planning tool that can be used in a variety of applications by planners and administrators of emergency service agencies. In practice, no emergency service system will ever conform to all of the model's assumptions exactly. Given the required data, the model computes numerical values for 11 performance characteristics. Seven likely applications of the model are described: police beat (sector) redesign, ambulance district design, assigning bilingual personnel to appropriate sector, assigning backup units to appropriate sectors, assigning overlapping police beats, determining assignment priorities, and preventive patrol design through patrol time assignments. The simplest possible use of the model is demonstrated employing a hypothetical system with three response units and seven geographical atoms. Interpretation of the computer output is reviewed, and sample output pages are provided. The following information is given in the output: verification of input data; mean travel times for each unit; estimated "cost" of dispatching each unit; and fraction of available time spent in each atom. The set up procedures for the data input cards are demonstrated. Each of the ten cards requires specific information prior to computer processing, and this information is described. Each of several input data options is discussed in detail, and input methodology is described for each. The glossary option allows the program user to input a city's unique labels for response units, neighborhoods, and districts into the program. Currently, printout options are very simple and limited, but eventually, they will be made more flexible, perhaps automatically suppressing detailed printout of poor runs. Three travel time data options are discussed in detail. Options for dispatcher selection allow the model to operate with any fixed preference dispatch policy. Other input data options include those for: police preventive patrol; default for locations of mobile units; nonsequential numbering of atoms; direction-specific traffic speeds; "rerun;" and service times that vary by response units. Several issues are discussed which may be considered complications in the use of the program in a particular application. The complications relate to the following issues: overlapping districts; ties for dispatch preference; and the use of center-of-mass dispatching strategies with arbitrary

inter-atom travel time. Methods for overcoming each complication are described. A technical summary is included which summarizes the operating procedures for the program and discusses technical issues.

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Grant NSF-GI38004
Rept. No. MIT-TR-14-75; 1975; 129p 7refs
Rept. on a res. proj. titled "Innovative Resource Planning in Urban Public Safety Systems."
Availability: Corporate author

HS-019 415

ANALYSIS OF STOCHASTIC NETWORKS IN EMERGENCY SERVICE SYSTEMS. TECHNICAL REPORT

Questions related to the analysis, design, maintenance, and repair of stochastic networks in emergency service systems are examined. Algorithms are developed to compute the number of simple paths between two nodes in a network and to compute the expected travel time between them. The implications of the stochastic aspect in the design problem of locating facilities to minimize the expected travel time to a random incident are examined subsequently. It is shown that the set of optimal locations consists of the nodes of the network when the utility function for travel time is convex. When the stochastic nature of each link is governed by a dynamic process, the system may be modeled, under certain assumptions, as a continuous-time discrete-state Markov process. It is shown that when the rate of repair of a link is proportional to the maintenance resources allocated to it, the optimal maintenance policy, which minimizes the expected travel time to a random incident, is to allocate all the resources to a single link. When many, if not all, the links of a network have failed so that nodes with nonzero demands are not connected to at least one facility, then the problem of repairing the network in minimum time becomes the problem of finding the Steiner subgraph of the given network. Some properties of the Steiner subgraph are derived and algorithms are presented to determine the Steiner subgraphs. An extensive literature review precedes each section. All the results of the report are derived for both oriented and nonoriented networks.

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Grant NSF-GI38004
Rept. No. MIT-TR-15-75; 1975; 256 100refs
Rept. on a research proj. titled "Innovative Resource Planning in Urban Public Safety Systems."
Availability: Corporate author

HS-019 416

COVERAGE MODELS OF EMERGENCY FACILITY CATEGORIZATION. TECHNICAL REPORT

Categorization of emergency facilities is meant to improve the match of clinical need to level of services received, to improve spatial access to care, and to reduce the cost of serving a region. For any given type and severity of emergency, facilities can be divided into two groups, called "definitive care facilities" and "stabilization facilities." Stabilization facilities prepare patients for transfer to definitive care facilities and are characterized by their relative cost and by the extent to which they reduce the risk of travel to definitive care. Mathematical models of facilities located randomly in an infinite plane are used to address the issue of the appropriate number of each type of facility. The mix of facilities is evaluated in terms of cost and "coverage," defined as the probability that a given incident in the plane is within a specified "effective distance" of a definitive care facility. The impact of patient routing on facility requirements is also examined.

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Grant NSF-GI38004; HEW-1-R21-HS-01658-01-HCT
Rept. No. MIT-TR-18-75; 1975; 38p 19refs
Rept. on a research proj. titled "Innovative Resource Planning in Urban Public Safety Systems."
Availability: Corporate author

HS-019 417

DISPATCHING THE UNITS OF EMERGENCY SERVICE SYSTEMS USING AUTOMATIC VEHICLE LOCATION: A COMPUTER-BASED MARKOV HYPERCUBE MODEL. TECHNICAL REPORT

Automatic vehicle location (AVL) systems present to the dispatcher of emergency response units (police cars, ambulances) the estimated real time locations of units within his service area. Building on a recently developed "hypercube queuing model," a Markov process model for computing the operating characteristics of the radio-dispatched fleet operating under a policy that dispatches the closest available unit to each call for service is presented. The model accommodates a realistic description of the service area and rather general spatial deployment policies for units. In implementing the model for efficient computer execution, the focus is on computation and storage, minimizing procedures for generating the state-to-state Markov transition rates. One useful technique involves the effective application of a recently developed backward regenerative unit-step tour of the hypercube. The algorithmic procedures generalize to computer solutions of M/M/N queuing systems with distinguishable servers, different customer classes, and a cost structure for assigning servers (who may be in one of several postures) to customers of each class. A realistic, nine-unit police example that indicates the general ways in which AVL dispatching improves (and degrades) system performance is provided.

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Grant NSF-GI38004
Rept. No. MIT-TR-21-76; 1976; 56p 13refs
Rept. for a research proj. titled "Innovative Resource Planning in Urban Public Safety Systems."
Availability: Corporate author

HS-019 418

COST EFFECTIVENESS IN HIGHWAY SAFETY

The National Highway Safety Needs Report of 1976 demonstrates how reliable information can lead to more judicious use of resources by indicating the improved levels of performance which may be realized with different expenditure levels. The report provides the basis for evaluating highway safety programs authorized under Title 23 of the United States Code,

and examines the cost and effectiveness of 37 highway safety safety measures, particularly those available for deployment during the next ten years, but not including vehicular safety safety measures. These have been ranked in order of decreasing potential to forestall fatalities and injury accidents. Thirteen target areas were identified: emergency response systems, driver behavior improvements (including alcohol abuse), young drivers, traffic enforcement and adjudication (includes alcohol abuse and 55 mph speed limit), bicycle and pedestrian safety, motorcycle safety, roadway safety improvements, roadside hazard elimination, traffic engineering and operations, vehicle safety operations improvements (including seat belt usage); program planning, evaluation and coordination; traffic records systems, and manpower resource development. The top ranking safety measure, mandatory seat belt usage, has the potential to save 89,000 lives during the next ten years at a cost of $45 million. Enforcement of the 55 mph speed limit, ranked second, could save 32,000 lives for $676 million. Cautious interpretation of information is urged due to data insufficiency, and limited research and experimentation. The report should be considered as a guideline to States, not a prescriptive. The report shows that there are limits to the effective use of public funds in highway safety. If all safety measures were adopted, more than $12 million would be spent to prevent each fatality. The report recommends: that mandatory safety belt use and the 55 mph speed limit be adopted; that pilot tests of the analytical approach to accident countermeasures should be conducted in several states, that more attention should be given to refining the report data base from which reliable accident exposure and target population estimates can be made; and that national safety performance should be reviewed periodically according to the analytical framework developed in this report.

by Robert Henri Binder
Publ: Highway User Quarterly p18-24 (Summer 1976)
1976
Availability: See publication

HS-019 419

PLASMA COATINGS EXPAND DESIGN OPTIONS

A variety of plasma-deposited coatings has been developed whose automobile applications range from brake drums to piston crowns. Researchers have also found special use for plasma coating in studies of a closed Rankine cycle steam power plant which could affect automobile engine use. Coating techniques stem from plasma arc research. Coating and substrate materials, as well as the operating parameters, all affect the final product. Among the properties of coating material to be considered are chemical composition, heat capacity, melting point, and powder particle size distribution. Aluminum oxide, chromium oxide, nickel, and tungsten carbide are several common coating materials. Important substrate characteristics include composition, shape, size, and surface roughness. Aluminum alloys have found widespread use as substrates because of their high strength-to-weight ratios, good thermal and electrical conductivities, and corrosion resistance. An alloy's relatively poor wear and friction characteristics can be designed out of the picture by appropriate choice of coating. Surface characteristics depend, in part, on the nature of the plasma. This can be varied by its gas composition, flow rate, current, and voltage, and by the angle, distance, and relative motion between torch and workpiece. By judicious juggling of these parameters coating engineers can produce pieces which combine the advantages of both coating and substrate. Microstructure and macrostructure of such a piece are illustrated in accompanying photographs. Surface condition of the substrate is an important factor in bond strength. It is important that the substrate have sufficient strength to sustain design loads. Temperature differentials play a role, both in process and in service. Corrosion protection must also be considered. The line-of-sight nature of the process sets geometric constraints. Coatings can be chosen to improve wear, friction, or corrosion characteristics. They can be applied in thickness from 0.001 to 0.020 inches. Automotive applications appear to offer cost-effective options in material and production; they offer an effective design option in applications where conventional materials are inadequate.

Publ: Automotive Engineering v84 n9 p26-9 (Sep 1976)
1976
Based on SAE-760230 "The Utilization of Plasma-Deposited Coatings on Aluminum," by R. C. Tucker, and on "Tribalogy Coating Success on Piston Rings and Cylinder Liners," by James A. McGeehan.
Availability: See publication

HS-019 420

GUIDELINES FOR DESIGNING TRAVEL SURVEYS FOR STATEWIDE TRANSPORTATION PLANNING. FINAL REPORT

Sampling procedures and travel survey designs are presented for application by States in their Statewide transportation planning programs. Procedures for minimizing nonresponse, noncontact, and other nonsampling biases are presented, and types of person travel data likely to be needed are identified for Statewide transportation planning programs. Alternative types of travel surveys which have been conducted for Statewide transportation planning and related programs are documented and evaluated. Person-related travel is focused upon as opposed to goods movement. Sampling concepts and procedures and a set of travel survey designs applicable to Statewide transportation planning are presented. Types of survey designs emphasized include: Statewide and regional household surveys; intercity bus passenger surveys; and alternative types of roadside surveys. These represent typical surveys which States anticipate conducting. Intercity bus passenger survey designs also may be used for surveying air carrier and intercity rail passengers. Elements of survey design emphasized include: selection and application of sampling procedures for estimating sample sizes and other sampling parameters; trade-offs between survey sample size and alternative tolerance and confidence levels; identification and reduction of nonsampling biases; and guidelines and generalized cost estimates for conducting each survey type. Real world planning scenarios are described and used to illustrate important sampling concepts and to demonstrate how to apply alternative sampling procedures. Potential default sample size estimates, means, and variances are presented where such estimates are based on actual survey data.

by John F. DiRenzo; Robert A. Ferlis
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Contract DOT-FH-11-8592
Rept. No. FHWA-HHP12-76-2; 1976; 300p 30refs
Prepared for the Federal Highway Administration study "Data Collection for Statewide Travel Including Multi-Modal Demands."
Availability: NTIS

HS-019 421

TIRE PROPERTIES AND TRUCK HANDLING: SOME SURPRISING NEW FINDINGS

Data are presented that expand present knowledge on truck tire traction as well as new findings on tire/vehicle interactions, particularly the truck's response to steering and braking inputs, and its maneuvering capabilities and limitations. These characteristics constitute major elements in the accident-avoidance quality of the driver-vehicle system. A heavy truck was rolled over accidentally during a turning maneuver test which was not considered likely to cause a turnover. From this accident it was learned that such vehicles have a lower yaw stability threshold than previously assumed. Conclusions concerning longitudinal traction properties state: commercial vehicle tires exhibit large falloff in longitudinal shear force capability at high values of slip; peak braking traction afforded by commercial vehicle tires is comparable to that obtained with passenger cars, although "slide" values are markedly lower; both peak and slide values of the braking traction of commercial tires normalized with respect to vertical loads are sensitive to the imposed value of vertical loads reducing their traction potential as load increases; slide values of braking traction reduce markedly with vehicle velocity; and the lug or cross-bar type truck tire exhibits lower levels of braking traction than tires configured with rib-type tread pattern. Conclusions reached concerning lateral traction properties state: a large range in values of cornering stiffness is available among the various tread and carcass constructions in the commercial market; cornering stiffness sensitivity to vertical load is the most significant lateral traction characteristic distinguishing the truck tire from the passenger car tire; the sensitivity of lateral traction to velocity is virtually insignificant for all tires examined; lateral force saturation of commercial tires occurs at normalized traction levels comparable to that obtained with passenger car tires; basic features distinguishing lateral traction properties of radial versus bias-ply tires, and rib-type treads versus lug-type treads, are in general common to both truck and car tires; dependency of cornering stiffness on inflation pressures distinguishes commercial vehicle tires from passenger car tires. Conclusions concerning mechanics of commercial vehicles state: the typical heavy truck is capable of eliciting a yaw instability while initiating a turn whose severity is muc:. lower than that needed to achieve limit response of passenger cars; a primary mechanism serving to aggravate truck yaw stability is the rear-biased distribution of suspension roll-stiffness; the use of tandem rear axles tends to improve the directional stability of fully loaded trucks and tractors markedly; the installation of differing tire construction at front and rear axles provides a powerful mechanism for influencing the directional behavior of light and heavy trucks; the directional behavior of heavy trucks and tractors is markedly sensitive to the longitudinal as well as vertical placement of the payload. The circular freeway exit ramps are seen as "ideal" setups for encountering the yaw instability phenomenon mentioned.

by Robert D. Ervin
Publ: HSRI Research v7 n1 p3-12 (Jul-Aug 1976)
1976
Availability: See publication

HS-019 422

AUTOMOBILE GASOLINE CONSERVATION

Three strategies for reducing automobile gasoline consumption were investigated: changes in power train technology, increasing the price of gasoline to the consumer and changing vehicle weight. Impacts of these strategies were then determined. Fuel economy could be improved through design changes in the automobile power train: relative to the conventional engine and transmission, a smaller power plant would yield equivalent power and improve fuel economy by as much as 30% with a continuously variable transmission. Several improved engine designs are suggested: diesel cycle, stratified charge, Wankel rotary, Brayton cycle or gas turbine, Rankine cycle or steam, Stirling cycle or hot air, electric, and electric/combustion hybrid. Engine development is still too preliminary to be considered a solution to fuel conservation. The effect of increasing gasoline prices on consumer behavior is assessed in three decision categories: overall gasoline purchases, automobile ownership, and driving patterns (route, time of day, use frequency). Econometric model formulations have been employed to study gasoline demand related to price, using aggregate time series data, and concentrating on short-term price elasticity and long-term market influences. Previous study results are not considered behaviorally valid with respect to simultaneous estimation of market demand for gasoline and automobiles on both short-term and long-term bases. The fuel economy to be gained by automobile weight reduction may be as much as 16% in some model classes. The interindustry impacts of weight-reduction alternatives (such as substituting aluminum and plastic for heavier metals and making smaller cars) are relatively small in relation to the gains which are possible. Gross national product and national employment would be reduced less than 1%, with petroleum and steel industries being most heavily affected. Other strategies for automobile gasoline conservation (55 mph speed limit, gasoline rationing, alternative sources of fuel, mass transit, traffic restrictions and controls, and new legislation) are not considered feasible at this time for short-term savings. The weight-reduction strategy has the greatest impact in reducing long-term automobile gasoline consumption. Recommendations are made to study consumer behavior and mass transit development as integral factors in future fuel conservation programs.

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Grant NSF-GI40615
Rept. No. UI-708-1; PB-253 489; NSF/RA-760081; 1976; 73p
46refs
A bibliography of selected Urban Inst. publications on transportation is also included.
Availability: Corporate author, $3.00 as URI 14100; NTIS as PB-253 489

HS-019 423

VEHICLE CLASSIFICATION SYSTEMS STUDY. FINAL REPORT

Several methods of classifying vehicles employing mechanical/electrical and television/videotape systems were field tested and evaluated to determine their state of development and possible future use in highway data collection activities. Mechanical/electrical systems tested consisted of an inductance loop detector with two pneumatic road tubes (or two road tubes alone) along with a solid state device which automatically classifies traffic into six categories by axle number

and axle spacing. Systems are suitable for both permanent installation and portable use. A permanent system was installed on Interstate 75 south of Atlanta, Georgia, which provides car and truck average speeds in addition to vehicle classification data via telemetry through a dedicated WATS line to a central office computer. The television/video tape system involves the use of a closed circuit television camera and time-lapse videotape recorder to provide a continuous visual record of the traffic stream from which vehicle classification data can be extracted manually from playback on a television monitor. Results of field testing these systems over a 3 1/2-year period indicated that further improvements are necessary and appear attainable before the mechanical/electrical systems can be used with confidence in practical applications. Problems encountered with the mechanical/electrical systems include misclassification of traffic due to tailgating and other features at 40 mph or less. Improvements are needed to make these systems as automatic as possible because manual adjustments can produce erratic data. Improvement is needed in the system input method involving air switches/road tubes. Perhaps the tubes should be replaced entirely with another workable method of point detection, as this means of input is a main source of misclassification. The television/videotape system is more accurate than other systems tested, but requires extra time and manpower for manual data extraction. More promise is seen in the mechanical/electrical systems for future applications.

by M. M. Alexander, Jr.; Ray Threlkeld; Jack Williams
Georgia Dept. of Transportation, No. 2 Capitol Square, Atlanta, Ga. 30334
Rept. No. PB-248 173; 1975; 62p 6refs
GDOT Res. Proj. 7108. Rept. for Sep 1971-Jun 1975.
Availability: NTIS

HS-019 424

SPEED OF VEHICLES ON GRADES. FINAL REPORT

A study to obtain new field data concerning motor vehicle operating characteristics on selected grades and to relate these data to current and future geometric design standards for highway grades was conducted. Particular emphasis was placed on the capacity and safcty aspects of vehicle climbing lanes, especially as they pertain to trucks and recreational vehicles, including car-trailer combinations. Phase 1 of the study was devoted to collection, review, and compilation of literature relating to the operating characteristics of motor vehicles on vertical curves. Phase 2 involved the design of a field data collection experiment, development of data collection techniques, and selection of data collection sites in central and east Texas. The data generated and compiled from field observations were analyzed and tabulated in phase 3 for comparison with current climbing-lane design criteria. From the analysis of data in phase 3, phase 4 developed a series of design charts based on vehicle classification, weight-to-horsepower ratio, approach speed, speed reduction, percent grade, and length of grade. These series of figures provide the highway designer with flexibility for evaluating design criteria for existing highway situations with more analysis tools than were previously available. Findings and recommendations cited in phase 5 provide revised climbing-lane design criteria based on the analysis of actual field data on the operating performance of trucks and recreational vehicles on selected representative grades. These recommendations are made: composite critical length of grade and speed-distance curve charts developed should be considered for application in evaluation of the need for and design of climbing lanes for trucks and recreational vehicles; an approach speed of 55 mph should be used for evaluation and design of climbing lanes; the current 15 mph speed reduction criterion should be retained as a compromise for providing better safety to the traveling public while not exceeding current austerity programs and priorities for other facilities within the state; and further evaluation and study of current climbing lane warrants, performance of vehicles on downgrades, vehicle equivalencies, roadway signing and marking of climbing lanes, and effect of driver behavior and experience on vehicle performance.

by C. Michael Walton; Clyde E. Lee
University of Texas at Austin, Center for Hwy. Res.
Rept. No. CFHR-3-8-73-20-IF; RR-20-IF; PB-253 436; 1975; 158p 85refs
Res. Proj. 3-8-73-20. A bibliography of research reports published by the Center for Highway Research is also included.
Availability: NTIS
1975; 65p 51refs
Proj. 95261.
Availability: Australian Road Research Board, 500 Burwood Rd., Vermont South, Vic., Australia

HS-019 426

CHARACTERISTICS OF DRIVING IN RELATION TO THE DRUG AND ALCOHOL USE OF FINNISH OUTPATIENTS

Characteristics of driving in relation to the drug and alcohol use of chronically ill outpatients have been examined through use of a survey administered to 765 rheumatoid arthritic, 715 tubercular, and 1,050 psychiatric outpatients and to 587 control subjects. Survey respondents were questioned concerning their use of drugs and alcohol and their driving habits and traffic accident involvement, and driving populations of all groups were matched for age and area of residence. Results of the study show a relatively small number of driver's license holders among rheumatoid and psychiatric outpatients, whereas the tubercular group included as many driver's licenses as did the control group. Also, the annual driving experience of the rheumatoid arthritic and psychiatric patients was lower. The main reason given for driving was recreation, and driving mainly took place on highways. Excluding the psychiatric patients, the outpatient groups had been involved less often in traffic accidents than the controls. The use of drugs correlated inversely with driving: the more drugs used, the less driving was done. Also, the consumption of alcohol increased in direct proportion to the number of kilometers driven: the greater the alcohol consumption per drinking session, the more annual driving and the more involvement in accidents. The types of drugs used by the outpatients were also evaluated for disabling effects, emphasizing the impairment features found with isoniazid, the most common antitubercular agent in Finland. But tubercular patients, in particular, had a low accident rate. An additional finding was that 41% of the control group used some kind of medication. It is concluded that although heavy drinking, in particular, correlates with greater risk of accident in traffic, alcohol consumption combined with drug use increases the risk factor.

by M. Maki; M. Linnoila
Publ: Modern Problems of Pharmacopsychiatry v11 p11-21 (1976)
1976; 5refs
Study supported by Liikenneturva and the Finnish Antituberculosis Association.
Availability: See publication

HS-019 427

A NEW ALUMINUM-LEAD BEARING MATERIAL FOR AUTOMOTIVE ENGINE SERVICE

A new aluminum-lead bearing material has been developed for intermediate duty applications, and has been tested for use in vehicle main and connecting-rod bearings. The use of powder metallurgy methods permits incorporation of a pure aluminum bonding layer into the strip as well as ensuring that the lead-tin bearing phase is contained in dispersed, intraparticle positions where it cannot interfere with interparticle bonding. The resulting bearing material has been shown to have fatigue resistance sufficient for intermediate-duty applications and is superior to that of existing bimetal aluminum-tin alloys. It also possesses improved wear resistance compared with the aluminum-tin alloy, as well as equivalent corrosion resistance. The laboratory performance of the alloy has been verified by hundreds of dynamometer and vehicle tests, in a wide variety of engines. Main bearings made from the alloy were tested for 512 test hours in a small, high-speed engine characteristic of European design, running the engine at speeds ranging from 4600 rpm to 6000 rpm at a constant 48 horsepower output. Connecting rod bearings from the alloy were tested for 374 hours in a typical domestic V-8 engine, using a cyclical test procedure varying engine speeds from 2000 rpm to 4000 rpm with engine loads from zero to 247 horsepower. Aluminum-lead connecting rod bearings were tested for 782 hours at 1800 rpm and 181 horsepower in a U.S.-built diesel engine. Results of all laboratory tests were satisfactory and superior to those obtained with other alloys. Large-scale field testing of the alloy was initiated in 1973, when a major U.S. automaker installed aluminum-lead straight shell main bearings in 50,000 production engines. To date, no problems or complaints concerning these bearings have been reported, a further verification of the excellent performance characteristics of the material.

by M. L. MacKay; L. J. Cawley; G. R. Kingsbury
Gould, Inc.
Rept. No. SAE-760113; 1976; 12p 7refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 428

TWO-PHASE, TWO-DIMENSIONAL, UNSTEADY COMBUSTION IN INTERNAL COMBUSTION ENGINES; THEORETICAL-EXPERIMENTAL RESULTS

A theoretical/experimental program to model two-dimensional, unsteady and steady two-phase flow combustion in internal combustion engines and steady reactors was carried out, testing and improving the model with parallel experimental programs. The research enables more detailed current understanding of this family of combustion problems to aid in development of cleaner and more efficient engines. Preliminary results of efforts to produce the model are discussed, showing the feasibility of detailed computations of combustion in internal combustion engines and how informative such computations can be for engine improvement efforts. Preliminary results are reported of detailed computations of two-dimensional, unsteady sprays penetrating and vaporizing into an inert gas in a closed volume (without combustion). Secondary preliminary results are given of detailed computations of an unsteady, two-dimensional fuel jet mixing and reaction with an oxidizer in the presence of an inert gas in a closed volume. A closely controlled experimental program on a single cylinder reciprocating engine is described which is designed to yield detailed measurements of the calculated quantities. All preliminary theoretical results are considered as intermediate steps toward the formulation and solution of a comprehensive model for two-phase, two-dimensional, unsteady, reactive turbulent flows. The experimental engine configurations were purposely selected to match closely those considered in the theoretical computations, putting emphasis on the need and usefulness of matching detailed theoretical and experimental studies of this family of complex combustion problems. The immediate application of the theoretical/experimental effort is to assess the feasibility of the optimal automobile power plant in features of high compression ratio, spark ignition, stratified charge, direct fuel injection, open chamber, medium-to-small displacement (750 to 500 cc/cylinder), high speed capability (up to 6000 rpm), and fuel insensitivity. The engine configurations which are being studied are attractive both from emission and efficiency viewpoints. It is predicted that eventually such a systematic theoretical/experimental approach to two-dimensional unsteady combustion will yield valuable results for the engine designer who has realized the need and usefulness of achieving a more precise control of the combustion process.

by F. V. Bracco; H. C. Gupta; L. Krishnamurthy; D. A. Santavicca; R. L. Steinberger; V. Warshaw
Princeton Univ., Aerospace and Mechanical Sciences Dept.
Grant NSF-AER-74-21220; NSF-AER-75-09538
Rept. No. SAE-760114; 1976; 18p 10refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 429

A PERFORMANCE MODEL FOR THE TEXACO CONTROLLED COMBUSTION, STRATIFIED CHARGE ENGINE

A model developed to predict the performance of the Texaco Controlled Combustion, Stratified Charge Engine (TCCS) divides the engine cycle into the following phases: intake, compression, rapid combustion, mixing dominated expansion, heat transfer dominated expansion, and exhaust. During the rapid combustion phase, the rate of heat release is assumed to be controlled by the rate of fuel injection and the air/fuel ratio. The burning rate in the mixing controlled stage appears to be dominated by the rate of entrainment of the surrounding gas by the plume of burning products, and this rate is assumed to be controlled by the turbulent eddy entrainment velocity. A plume geometry model has been developed to obtain the surface area of the plume for entrainment during the mixing dominated phase. The model also gives the wall areas in contact with the hot, burned gas plume and the relatively cold unburned gas for heat transfer calculations. Comparison of the model predictions with the available experimental data shows good agreement. In addition, the potential of the TCCS engine performance model as a design tool is demonstrated with a parametric analysis. Appendices give additional information on fuel/air mixing in the TCCS (characteristic length analysis, jet breakup, deceleration of droplets, droplet vaporization, mo-

mentum length considerations, and jet model), and the plume geometry model and heat transfer relations in three stages.

by B. C. Jain; J. M. Rife; J. C. Keck
Massachusetts Inst. of Tech.
Contract DAAE07-73-C-0282; DAAE07-74-C-0268; DAAE07-74-C-0168
Rept. No. SAE-760116; 1976; 22p 21refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976. Work subcontracted from Texaco, Inc. under contracts.
Availability: SAE

HS-019 430

EFFECTS OF THE DEGREE OF FUEL ATOMIZATION ON SINGLE-CYLINDER ENGINE PERFORMANCE

An investigation was conducted to determine the effects of the degree of fuel atomization on exhaust emissions, fuel consumption, lean limit, minimum for best torque (MBT) spark timing, and cyclic variations in peak cylinder pressure. A single-cylinder engine was used to isolate the effects of atomization on combustion from the additional effects of maldistribution that would be present in a multicylinder engine. Three degrees of gasoline atomization were investigated, along with the case of a well-mixed charge of gaseous propane. The degrees of atomization investigated varied from good (10-20 micrometer droplets) to bad (400-700 micrometer droplets) to wall-wetted (400-700 micrometer droplets deposited on the intake port walls). Results from the investigation show that the degree of atomization can have considerable effect on exhaust emissions, but little effect on fuel consumption. Generally, as atomization deteriorated, hydrocarbon emissions increased; nitric oxide and carbon monoxide emissions increased for certain air/fuel ratio ranges; MBT spark advance decreased; lean limit was extended; and cyclic variations in peak cylinder pressure decreased. It was hypothesized that the case of "good" atomization resulted in an essentially homogeneous charge of vaporized gasoline and air at the time of ignition, while the cases of "bad" and "wall-wetted" atomization resulted in inhomogeneous changes. That is, some form of stratification of the fuel/air mixture existed. Results are discussed in relation to this hypothesis and are shown to be consistent with it.

by William R. Matthes; Ralph N. McGill
General Motors Corp., Research Labs.
Rept. No. SAE-760117; 1976; 20p 17refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 431

THE FUTURE ROLE OF ELECTRIC LAND TRANSPORTATION IN THE UNITED STATES

Data for assessing the impacts on urban driving patterns, energy use, petroleum consumption, air pollution, travel costs, and resource consumption were obtained from comprehensive studies of electric car use for the Energy Research and Development Administration (ERDA) and the Environmental Protection Agency (EPA). The principal incentive for the electric car is energy substitution: utilizing coal and nuclear energy rather than petroleum. Electric vehicles would be seen in urban areas where battery exchange and recharge facilities can be made available. The types of batteries available and in development for electric vehicles indicate the ranges of travel which are possible: lead-acid, 54 miles; lithium-sulfur, 138 miles; nickel-zinc, 144 miles; and zinc-chlorine, 145 miles. A survey in Los Angeles, Calif., showed that an urban driving range of 140 miles would satisfy around 98% of drivers. The capability of the lead-acid battery would suffice on about 98% of driving days, if the car were employed as a second car in a household with a primary car of much greater range. Overall energy use of the electric vehicles has been compared with conventional cars of average and subcompact size showing that electric subcompacts appear more energy-economical than the average internal combustion engine car, but less so than internal combustion engine subcompacts of similar size. Performance gradients also differentiate the energy efficiency of the vehicles studied, giving a further edge to a low-performance subcompact internal combustion engine vehicle. But petroleum use is the weighted factor, rather than overall energy use, giving a clear advantage to electric vehicles over those which consume petroleum fuels. Air quality would be relatively little affected by electric car use, and costs of auto travel would be substantially increased until advances in battery technology permit major reductions in battery depreciation costs. Also, battery materials resources could be a problem for national use of electric cars beyond the 5-10% level. In conclusion it is apparent that even lead-acid battery technology can enable electric autos to be widely applicable in urban areas as second cars notwithstanding the limitations and costs involved.

by Graham Hagey; William Hamilton
Energy Res. and Devel. Administration; General Res. Corp.
Rept. No. SAE-760118; 1976; 10p 8refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 432

A STUDY OF THE ENERGY UTILIZATION OF GASOLINE AND BATTERY-ELECTRIC POWERED SPECIAL PURPOSE VEHICLES

An analytic study was conducted to compare the efficiency of using fossil energy resources (petroleum and coal) in battery-electric and gasoline powered special-purpose urban vehicles. The study was restricted to three special-purpose cars that are smaller and have lower performance than conventional subcompact cars and to a delivery van. The vehicle power train components represent demonstrated current technology. The most important guideline of the study required the performance levels and load-carrying capacity of the gasoline and electric-powered vehicles to be the same. The four vehicles (two-passenger shopper, two-passenger commuter, four-passenger sedan, and the delivery van) were outfitted with gasoline engines and battery-electric power in order to compare their fuel efficiency in parallel trials. Operation of the entire vehicle powertrain system was simulated using a complex system of computer programs developed for this purpose. Standing start, full throttle acceleration performance, gradeability, and driving schedule operation for the battery-electric and spark ignition engine powered vehicles were examined during the course of the study in order to satisfy the performance criteria established. Average driving cycle operating efficiencies then were ascertained for vehicle components by engine type: electric vehicle (motor or engine 74%, driveline 80%, battery and charger 70%, overall 41%) and spark ignition vehicle (motor or engine 23%, driveline 78%, no value for battery and charger, overall 18%). Furthermore the energy

production and distribution efficiency of gasoline and electricity from petroleum and coal, respectively, were estimated. Gasoline production efficiency was 89% from petroleum and 49% from coal, and electricity production efficiency was 29% from petroleum and 31% from coal. Prime source energy consumption ratios, or the electric vehicles compared to the spark ignition vehicles, show that a battery-electric powered vehicle utilizes petroleum-derived energy much less efficiently than an identically performing spark ignition engine powered vehicle. The use of advanced high energy batteries, increased efficiency electric components, and significant electric vehicle mass reductions cannot reverse this situation. It is concluded that only if petroleum is unavailable for use is there an energy consumption advantage for electric vehicles.

by David C. Sheridan; John J. Bush; William R. Kuziak, Jr.
General Motors Corp., Res. Labs.
Rept. No. SAE-760119; 1976; 19p 17refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 433

ENERGY ANALYSIS AND THE ELECTRIC CAR

The energy consumption used in construction and operation of a variety of cars is calculated and compared: three subcompacts (an internal combustion engine (ICE) powered reference vehicle, a 45-horsepower electrical metropolitan car with lead acid batteries, and a 35-horsepower town car with lead acid batteries) and a compact ICE vehicle, and a hypothetical electric vehicle with a sodium sulfur battery. Estimation shows that over the lifetime of the vehicle operating energy over the lifetimes of both electric and gasoline cars exceeds construction energy by a factor of from 2.3 to 8.0 (electric vehicles requiring the higher initial investment). Overall, the difference in energy requirements of the two types of propulsion systems is not large. Large direct fuel savings are unlikely to result from the application of electric vehicles using battery power sources. Speculation arises on the effect of using fuel cells for vehicle energy requirements. Energy consumed in constructing the fuel cell and modifying the vehicle to accommodate the fuel cell would be on the same order as a 30 kWh battery. If the thermal efficiency of a fuel cell were estimated at 40%, its application in an electric vehicle would provide about twice the net overall efficiency of the gasoline engine in vehicle service. The electric battery vehicle will require at least as much construction energy as a gasoline powered equivalent. To avoid the significant construction required for current short-lived battery production, batteries with a longer life must be developed. It is concluded that although some small net savings would result from the use of battery vehicles, these savings are sensitive to the efficiency of electricity generation. Development of a successful and economic fuel cell would provide a significant advantage to electric vehicles for future applications.

by K. R. Williams
Shell International Petroleum Co., Ltd.
Rept. No. SAE-760120; 1976; 8p 8refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 434

HYBRID VEHICLE FOR FUEL ECONOMY

A heat engine/electric hybrid drive train is proposed as a means for improving CVS-hot driving cycle fuel economy in various types of automotive vehicles. This drive train, classified as a parallel hybrid, has been analyzed by means of computer simulation studies to evaluate its fuel economy, performance, and emissions characteristics, and has been compared with existing internal combustion engine drive trains and other types of hybrid drives. A prototype system was assembled and evaluated on a dynamometer test stand, and has corroborated the computer analysis and predictions. The system is shown to be capable of overcoming many of the deficiencies and problems of earlier hybrid systems through proper matching of hybrid engine to vehicle weight, use of a single electrical machine for both motoring and regenerative operation, design of the electrical branch of the hybrid on the basis of short-time power requirements rather than energy requirements, and maximum exploitation of engine control to achieve both efficient operation and relatively low emission levels. Analytical and dynamometer test results show that present CVS-hot fuel economies of existing engine power vehicles can be improved by 30% to 100% while meeting 1975/1976 Federal Emission Control requirements using catalytic converters. The percent improvement in fuel economy is largely a function of vehicle weight and performance with the larger increases occurring on the larger, high-powered vehicles. Presently, nickel cadmium batteries appear a feasible choice for the energy storage device in the electrical branch of the hybrid. As a result, substitution of a hybrid drivetrain for a conventional drivetrain would result in a cost penalty on initial vehicle cost. Factors underlying the increased fuel economy of the hybrid configuration tested are: the engine used in the hybrid was operated in regions of minimum specific fuel consumption during a much greater portion of its operating time than in conventional drives; the idling condition on the engine was eliminated; and regenerative braking was used. Other problems that must be solved before production can begin include: drivetrain packaging in a real vehicle; battery maintenance; engine lifetime under increased loading; supplying power to vehicle auxiliaries; development of the best vehicle control system to achieve driveability; driveshaft, differential, and rear wheel performance during regenerative braking; and larger battery energy capacity.

by L. E. Unnewehr; J. E. Auiler; L. R. Foote; D. F. Moyer; H. L. Stadler
Ford Motor Co., Res. Staff
Rept. No. SAE-760121; 1976; 20p 17refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 435

AN ANALYTICAL STUDY OF THE FUEL ECONOMY AND EMISSIONS OF A GAS TURBINE-ELECTRIC HYBRID VEHICLE

A study was made to determine the effect of hybrid operation on the fuel economy and emissions of a vehicle using a gas turbine engine, a continuously variable transmission, and an electric power storage system. Both series and parallel hybrids were considered in an 1815-kg vehicle. To facilitate this study, a computer program was written which modeled the vehicle and, using experimental data, computed its fuel consumption

vehicle may be reduced as compared to its nonhybrid counterpart, but under other conditions they may be increased. It is not possible to reduce fuel consumption and all of the emissions simultaneously. The reduction of one pollutant is usually accompanied by an increase in one of the others. The extent of the reduction or increase experienced with hybrid operation depends on the particular type of hybrid and on the engine operating conditions. Relative effects of minimizing fuel consumption or any of the various pollutants are demonstrated, and show that the hybrid offers a small decrease in fuel consumption as compared to the standard car and at the expense of increased oxides of nitrogen emissions. Minimizing unburned hydrocarbons reduces fuel consumption, but at the expense of increased oxides of nitrogen. Both fuel consumption and oxides of nitrogen emissions are increased when carbon monoxide is minimized. Very large increases in fuel consumption and in unburned hydrocarbon and carbon monoxide emissions result from minimizing oxides of nitrogen emissions. The use of the hybrid systems can reduce oxides of nitrogen emissions by 13% or increase them by 77% depending on the type of hybrid used and the engine operating conditions. Fuel consumption as tested varied between a reduction of 5% and an increase of 139% compared to the standard car, depending on the type of hybrid and the operating schedule. There was no optimum engine operating point found for low emissions and high fuel economy with the hybrid engines. It is concluded that while the hybrid vehicle has special advantages in some situations, it cannot be considered as the solution for either fuel economy or emissions problems.

by Sidney G. Liddle
General Motors Corp., Res. Labs.
Rept. No. SAE-760122; 1976; 16p 11refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 436

A PURPOSE-BUILT ELECTRIC TAXI

Technical viability of designing a vehicle to meet the design requirements of a London taxi is demonstrated in a vehicle using electric drive assisted with advanced lead/acid traction batteries. The vehicle developed is 3 ft (1 m) shorter than the traditional London taxi, and the cab is 1.5 in. (37.5 mm) wider. Five of the vehicles would fit in the parking space presently required for four regular London taxis. The result of development is a vehicle which could come into immediate service since it meets all requirements of the Metropolitan Polic Public Carriage office. Both operators and drivers of traditional taxis were consulted during the vehicle development program, ensuring general characteristics known to meet with user requirements. For passengers these requirements include ease of access to luggage storage and direct communication with the driver. Special advantages for the taxi driver include improved visibility, adjustable foot pedals, improved instrument and interior layout, and removal of rear stowing shelves to eliminate forgotten passenger possessions. Construction parameters included: low interior noise level, inexpensive body tooling, present and foreseeable crash protection regulations, and minimum time for repairs (especially accident damage). The vehicle as developed also retains the subjective sense of occasion inherent in using a London taxi, a factor in its public acceptance. Two such vehicles have been built to date, one of ment of the two test vehicles and their expected derivatives is scheduled to continue.

by P. Warner
David Ogle, Ltd.
Rept. No. SAE-760124; 1976; 8p 2refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 437

FUTURE FUEL INJECTION SYSTEM REQUIREMENTS OF DIESEL ENGINES FOR MOBILE POWER

Several parametric studies to determine design parameters for optimum fuel systems of diesel engines were surveyed for injection pressure effects, thermal efficiency considerations, and controls for operation. The studies on injection pressure have indicated that an increase in fuel injection rate and/or pressure improves the brake specific fuel consumption and reduces the smoke level of engines tested. Development of advanced fuel-injection systems have produced systems hyydraulically actuated so the parameters of injection pressure and rate can be controlled independently of engine rotational speed, and timing can be externally controlled with complete flexibility, both injection pressure and timing can be surveyed rapidly over board ranges on an operating engine, and injection rate and injection duration can be adjusted by changing the nozzle orifice area at a given injection pressure. The work conducted with model fuel-injection systems indicates that the maximum benefit cannot be realized by simply installing them on engines with combustion systems matched to conventional injection systems. The capabilities of fuel injection techniques show promise in development of engines with higher efficiencies and lower exhaust smoke levels over the complete operating load-speed range if the injection characteristics can be optimized at each point. A procedure has been demonstrated to select the proper injection pressure level for a direct injection combustion system specified, establishing the upper limit (150 mpa (21,750 psi)) based on an ideal injection system. However, practical considerations require a much lower efficiency prediction for future consideration. It is apparent that once the combustion characteristics of a given system are esiablished, the efficienct of the injection system becomes a factor in determining the optimum injection pressure level for the engine. Several factors of thermal efficiency have also been investigated (timing, optimum heat release, and shaping of cylinder firing pressure curve). Parameters of design of the basic combustion system which provide a short combustion duration with control of initial characteristics when high pressure injection is available are listed minimize ignition delay: optimize the fuel/air mixing process and reduce the tail-off of heat release rate at the end of combustion. The optimization of the diesel engine also requires the combustion process to be shaped and tuned at each operating point, signifying the need for developing means of controlling the injection process (timing, injection rate, and shape of injection rate curve) at each point in the speed-load operating range of the engine. Specification for an advanced fuel-injection system are given targeted toward the goals of highest brake thermal efficiency possible, no visible black smoke production throughout operating ranges of the engine, lowest possible odor and irritant

emission, minimum oxides of nitrogen and hydrocarbon emissions, and ability to reduce combustion-generated noise levels to acceptable levels. Specifications include injection pressure to 100 mpa (14,500 psi), injection pressure control as a function of engine speed and load, injection rate control, timing schedule control as a function of both speed and load, engine nozzle configuration to eliminate stored fuel, injection metering tolerances with compenstion mechanisms, injection timing tolerances, general controls capabilities and general system specifications suitable for engine adaption.

by R. F. Parker
John Deere Product Engineering Center
Rept. No. SAE-760125; 1976; 11p 18refs
Presented at Automotive Engineering Congress and
Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 438

THE ROLE OF FUEL INJECTION EQUIPMENT IN REDUCING 4-STROKE DIESEL ENGINE EMISSIONS

A penetration is forecast of the diesel engine, in both direct and indirect form, into the medium and pickup truck market in the U.S. and into the light truck, van, and car market in Europe. Consequently technical requirements in terms of engine and fuel injection equipment performance need specifying. For the purposes of discussion an assumption is made that invisible emissions legislation for oxides of nitrogen and unburned hydrocarbons will not be more stringent than 5 grams/brake horsepower hour combined (using the EMA 13 mode cycle), or 2.0 and 0.41 grams/mile, respectively (using the LA4 CVS cycle). The variables which the fuel injection equipment engineer considers are dynamic fuel injection timing, injection pressure, diagram shape, and nozzle configuration. These variables can be selected and improved to attain the performance requirements of future diesel engines. In practice such considerations often mean acceptance of trade-off effects, such as meeting smoke production limits by limiting injection pressure or timing the fuel injection, but with attendant losses in economy. In different sized engines it has been found that the optimum injection pressure required is relatively unaffected by cylinder swept volume, but increases with turbocharging level. The scheduling of fuel injection timing is considered a more potent means of meeting performance requirements in two ways: as the speed of the engine increases, there is a decrease in time available for combustion to occur before the descent of the piston cools the gases; and as the fueling rate decreases, cylinder temperatures drop generally and the misfire limit of timing advances. The advanced fuel injection system must therefore control two timing characteristics: speed advance and light load advance. The improvement in fuel injection systems should also be matched by equipment changes and improvements in engine design. In particular, swirl levels and compression ratio can be matched from cylinder to cylinder, and the swirl levels can also be matched to the aspect ratio of the combustion chamber. Other techniques are also available to improve the operation of fuel-injected diesel engines: improved accuracy of fuel-pump setting, improved accuracy and consistency of nozzle hole size, reduction of nozzle sac volume, reduction of mass of nozzle moving parts, and reduction of fuel injection equipment mechanical noise. The areas in which developments in fuel-injection equipment are required may or may not be associated

hydrocarbons from nozzle sac, and reduction of pump noise. New design and production techniques with respect to nozzles, distributor pumps, and inline pumps promise to produce systems capable of meeting future legislated requirements for performance in terms of emissions, smoke, and noise, with the best combination of fuel economy and total engine cost.

by H. C. Grigg
CAV Ltd.
Rept. No. SAE-760126; 1976; 14p 4refs
Presented at Automotive Engineering Congress and
Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 439

NEW ROBERT BOSCH DEVELOPMENTS FOR DIESEL FUEL INJECTION

Work on fuel injection equipment development at Bosch Corp. corresponding to progress in development of the diesel engine has emphasized specific injection quantity per camshaft degree at full load (injection rate) and peak pressure required for this purpose. Specific Bosch equipment developments include: the inline pumps MW and P-S 4000, the distributor type pump VE, new accessories for the approved governor types, and hole type nozzles with reduced needle mass, without sac hole, and without oil leak. The M-size and A-size inline pumps are of the classical one side open design employed on light multicylinder injection pumps. The MW-, P-, and P-S 4000 injection pumps are designed for higher peak pressure (more than 10,000 psi). These pumps and associated governors meet optimal pressure and sealing requirements as well as providing flexibility in production and service. A timing device is also available as an optional attachment for the inline pumps. The distributor type pump is based on the basic EP/VA pump, generating high pressure by the plunger lift and distributing the fuel from cylinder to cylinder by the rotation of the plunger. The pump is independent in function to its position in the engine, and fuel flow can be adjusted on the running engine, a feature offering optimum flexibility for the engine manufacturer. Furthermore, the VE pump can be run without additional feed pump. The pump contains an integrated supply or transfer pump, timing device, and a mechanical or electrical shut-off device, with the governor available in all speed or minimum/maximum configuration as well as in a combined version called the road speed governor. In its basic design the governor can be equipped with plus or minus torque control, with the timing device controlled by speed and load. New accessories developed for the approved governor types include plus/minus torque control, aneroid, electrohydraulic stop, and temperature-controlled electrohydraulic fueling. Improvements in the nozzles and nozzle holder assemblies of the fuel injection system have also been made, resulting in proper opening sequence, improved atomization and distribution performance, and automatic closure without secondaries. The continuing task of outfitting diesel engine developments with corresponding improvements in fuel injection systems will continue to progress along at least three fronts: extension of the existing program to improve design principals in production, operation, and service; combination of current production basis with advanced technology (such as integrated electronics); and new

approaches with advanced systems (prototype research and development).

by Klaus D. Zimmermann
Robert Bosch G.m.b.H., Germany
Rept. No. SAE-760127; 1976; 14p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 440

A TRANSIENT SPRAY MIXING MODEL FOR DIESEL COMBUSTION

A transient spray mixing model forming the basis of heterogeneous combustion in direct injection diesel engines is described. Experimental results of transient fuel sprays in a high-pressure, high-temperature chamber provided data for developing spray growth equations. Use of similarity of concentration profile across the spray in conjunction with spray geometry and mass conservation yields a complete description of spatial and temporal fuel/air distribution. Fuel preparation and air entrainment rates are calculated from the history of fuel/air distribution. Progressive evolution of combustion zones is determined by the fuel/air mixing process. Energy conservation and chemical kinetics calculations in each zone yield cylinder pressure and local nitric oxide concentration. The role of fuel/air mixing in diesel combustion is discussed with relation to atomization and evaporation, air motion, tip penetration, spray trajectory, tail movement, shape of spray cross-section, shape of spray front, effect of combustion on spray geometry, and initial conditions (engine operating conditions, air swirl rates, ignition delay, fuel injection rate or pressure, and compression pressure and temperature), concentration distribution, conservation of fuel mass, effect of wall impingement, mixing after fresh air depletion, combustion zone division, mixture preparation, rate of change of zone mass, and calculation of composition, energy, and kinetics. Model results are compared with experimental data from tests on a single-cylinder engine over a wide range of operating conditions. Parameters included engine speed, load, injection timing, injection pressure and duration, number of spray holes, intake air pressure and temperature, compression ratio, and swirl level. Tape-recorded cylinder pressure was digitized and averaged over 50 cycles, and measurements were made of fuel rate, torque, and emissions. Correlation between measured and calculated values of work is achieved within plus or minus 2% agreement for all operating conditions. A similar comparison of measured and calculated nitric oxide was made, achieving generally good agreement but with wider data scatter.

by W. S. Chiu; S. M. Shahed; W. T. Lyn
Cummins Engine Co., Inc.
Rept. No. SAE-760128; 1976; 14p 24refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 441

MODELS FOR COMBUSTION AND FORMATION OF NITRIC OXIDE AND SOOT IN DIRECT INJECTION DIESEL ENGINES

A mathematical model was developed for predicting the concentration of exhaust nitric oxide, soot, and other emissions in a direct-injection diesel engine. The prediction was based on data concerning a single droplet as well as the droplet size distribution in a fuel spray and the spatial and temporal distribution histories of fuel in a combustion chamber. The heterogeneous field of temperature and equivalence ratio and the uniform pressure in the cylinder were postulated. The heat release model gives the burning rate of injected fuel and pressure and the temperature history in the cylinder. The concentration of nitric oxide and soot in the cylinder was predicted by the emission formation model. The calculated results were compared with the experimental results for a typical direct-injection diesel engine in order to confirm the validity of the theoretical analysis. The model developed is regarded as a potentially useful tool for evaluating approaches for control of exhaust emission. Nomenclature and appendices giving the equations for spray tip penetration, droplet size distributions, and evaporation of liquid droplets are included.

by H. Hiroyasu; T. Kadota
University of Hiroshima
Rept. No. SAE-760129; 1976; 16p 30refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 442

FUEL AND ADDITIVE EFFECTS ON DIESEL PARTICULATE DEVELOPMENT AND DEMONSTRATION OF METHODOLOGY

Methods for the sampling and analysis of diesel particulate emissions were developed so that the effects of fuel and additive composition on emissions could be determined. Effort was centered on development of sampling and measurement procedures for reproducible determination of diesel particulate mass emissions, development of analytical procedures for identification of potentially harmful substances in particulate matter, and demonstration of the sampling and analysis methodology using six fuels (or fuel-additive combinations) in both a four-stroke cycle diesel engine and a two-stroke cycle diesel engine. Engines were operated for testing in both individual steady-state modes and according to a variation of the 13-mode diesel emissions measurement procedure. The primary particulate sampling technique employed was a dilution tunnel, and secondary evaluation techniques included a dilutersampler, a light extinction smokemeter, and a filter-type sampling smokemeter. Gaseous emissions were also measured, providing a running check on engine condition. Particulate mass rates were calculated from gravimetric data, and analysis of particulates included determination of sulfur, carbon, hydrogen, nitrogen, phenols, nitrosamines, trace metals, and organic solubles. Analysis of the organic soluble fraction included NMR, IR, paraffin boiling point distribution, benz (a)pyrene, sulfur, carbon, hydrogen, nitrogen, and oxygen. The most valuable types of analysis for future diesel particulate research include determination of sulfur, carbon, hydrogen, and nitrogen in particulate; total particulate mass; total organic solubles; sulfur, carbon hydrogen, nitrogen, and oxygen in organic solubles; benz (a)pyrene; metals; boiling point distribution of solubles and paraffin fractions; NMR and IR analysis (limited); phenols; and smoke by the smokemeter. Nitrosamine analysis and Bosch smoke tests are not needed in future diesel particulate research unless a special need exists. The dilution tunnel technique, with attention to calibration and sizing of flow systems, appears to be accurate and repeatable for determining particulate mass rates and mass rates of par-

ticulate constituents, and is recommended as the reference method for future studies of diesel particulate. Specific particulate emission rates were strongly influenced by fuel type and by the presence of the organometallic smoke-suppressant additive. As a general trend, particulate mass emission rate and smoke density from both engines increased with increasing power output at steady speeds. Appendix A gives detailed information on the particulate composition analysis procedures. Appendixes B and C describe average particulate mass rates and compositions and composition of particulate and organic solubles.

by Charles T. Hare; Karl J. Springer; Ronald L. Bradow
Southwest Res. Inst.; Environmental Protection Agency
Contract EPA-68-02-1230
Rept. No. SAE-760130; 1976; 32p 10refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 443

THE MEASUREMENT AND ANALYSIS OF THE PHYSICAL CHARACTER OF DIESEL PARTICULATE EMISSIONS

Methods for collecting particulate matter samples in undiluted diesel engine exhaust gases with an Andersen Inertial Impactor for gravimetric and electron microscopy analysis were developed, tested on a direct injection V-8 naturally aspirated engine, and shown to be efficient. Physical characteristics of the diesel particles are described in terms of size distribution and content of carbon, hydrogen, and nitrogen. Particulate matter collected on filters was analyzed for size distribution for engine conditions applicable to the Society of Automotive Engineers 13-mode cycle using both scanning and transmission electron microscopes and was found to be comprised of individual spherical particles ranging from 100 angstroms. A correlation made between the number of individual spherical particles in an agglomerate and the agglomerate size revealed a particle number range from a single, 100 angstrom particle to an agglomerate 30 micrometers in diameter containing an average of 4000 of the individual spherical particles. The solid particulate matter collected within the sampler had a carbon/hydrogen ratio that is temperature-dependent, ranging from 0.75 at an exhaust temperature of 100° to approximately 5.0 at exhaust temperatures greater than 300°. This change indicates that the organic matter believed responsible for the shift in agglomerate size is condensed hydrocarbons with a carbon/hydrogen ratio of approximately that of typical hydrocarbon fuels. The Beer-Lambert Law provides a means of approximating the particulate concentrations by smoke opacity measurement.

by Carl T. Vuk; Martin A. Jones; John H. Johnson
John Deere Product Engineering Center; Michigan Technological Univ.
Grant EPA-R802596020
Rept. No. SAE-760131; 1976; 45p 22refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 444

COMBUSTION CHARACTERISTICS OF DIESEL FUEL BLENDS CONTAINING USED LUBRICATING OIL

An experimental program was conducted to determine the e fect of burning used lubricating oil mixed with fuel oil in a si gle-cylinder diesel engine as a measure both to provide altern tive fuels and simultaneously dispose of large quantities used lubricating oil that are currently available. The us lubricating oil/fuel oil ratios used in the study were 2.5%, 5% 10%, and 15% used lubricating oil by volume. The effect burning these blends on emissions of unburned hydrocarbo (HC), carbon monoxide (CO), and oxides of nitrogen (NO was studied and compared to baseline values obtained in bur ing pure diesel fuel. Tests were run at 1800, 2400, and 30 rpm at 0.25, 0.50, 0.75, and full rack positions for each fu blend. Results show that for HC emissions, 5% used lubrica ing oil gave best overall results. HC concentration was also function of speed, being lower at 2400 rpm than at 1800 3000 rpm. At full rack and 3000 rpm for 15% used lubricati oil the HC emissions became unacceptable in comparison the baseline value for the same conditions. CO emission f blends tested was minimum at 5% used lubricating oil. The was little variation of CO concentration over the range blends tested, with no excessive value at any condition test relative to baseline values. NOx decreased as the percenta of used lubricating oil was increased, and was mo pronounced at 2400 rpm. There was no appreciable differen in smoke density or mass of emitted particulate matter co pared to baseline values obtained, and there was no excessi metal concentration in the emitted particulate matter compar to that found in use of straight fuel oil. Smoke production w almost always lower when straight fuel oil was burned, but t increase in smoke at low used lubricating oil concentratio (2.5% and 5%) was not excessive. Thermal efficiency w usually best using straight fuel oil and decreased as the p centage of used lubricating oil increased. No abnormal engi wear was observed, although deposit formation was higher a might pose a problem after extended running periods. No de sion was reached with regard to the advisability of usi blended fuel oil/used lubricating oil in diesel engines due to need for additional analysis and testing.

by R. L. Bechtold; S. S. Lestz
Pennsylvania State Univ.
Grant EPA-R802425
Rept. No. SAE-760132; 1976; 14p 12refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 445

A PRELIMINARY MATERIALS SELECTION GUIDE

A preliminary materials selection guide for use in select general types of materials for a specific application has be developed, comprising a series of bar charts and an associa work sheet. The guide is seen to function as a forerunner le ing to other, more specific, selection guides. In addition to conventional engineering properties represented in the charts, new cost and energy consumption parameters w defined and represented in bar chart format: relative pri volumetric price, price/rigidity ratio, energy consu tion/strength ratio, and volumetric energy consumpti Materials described in the guide include steels, cast irons, a

minum alloys, copper alloys, zinc alloys, magnesium alloys, nickel alloys, lead alloys, tin alloys, titanium alloys, miscellaneous metals, ceramics, plastics, and rubbers. Bar charts comparing the characteristics of these materials cover yield strength, tensile strength, approximate hardness, modules of elasticity, relative price, compressive strength, elongation, volumetric price, price/rigidity ratio, specific gravity, thermal expansion coefficient, thermal conductivity, specific strength, specific stiffness, energy consumption/strength ratio, volumetric energy consumption, electrical resistivity, maximum use temperature, and specific heat. One possible method of using the guide is demonstrated by considering the solution of a sample problem where a material was needed for a bearing bracket exhibiting minimal elastic deformation at relatively high levels of loading, with consideration for energy resources consumption and economic parameters. An appendix describes approximate hardness conversions for use with the guide.

by R. T. Wimber
Deere & Co.
Rept. No. SAE-760139; 1976; 32p 12refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 446

ECONOMY WITH REDUCED EXHAUST EMISSIONS--A SIMPLE TECHNIQUE

The use of a coolant heated inlet tract heat exchanger to completely vaporize the fuel in the inlet charge is shown to be a satisfactory method for producing a homogenous mixture and good cylinder-to-cylinder distribution in a conventional, carbureted, gasoline engine, thus producing economical running with reduced exhaust emissions. The improved distribution technique makes it possible to run the engine on an air/fuel mixture sufficiently lean to give large reductions in emissions of carbon monoxide, hydrocarbons, and nitric oxides. Tests with the system fitted to a car have shown that driveability is not seriously impaired, while control of emissions in actual driving conditions is satisfactorily achieved. Advantages of the technique are: simplicity; not expensive; no major engine modifications required; fuel consumption reduction; exhaust emissions reduction; and special lead free fuel not required. Disadvantages are that engine power output is reduced by up to 30% and the device does not operate until the engine has warmed up. Further refinements in the heat exchanger system are contemplated in areas of compactness and ease of installation.

by D. W. Hughes; J. R. Goulburn
Ashby Inst., Queen's Univ. of Belfast, Northern Ireland
Rept. No. SAE-760140; 1976; 14p 16refs
Presented at Automotive Engineering Congress and Exposition, Detroit 23-27 Feb 1976.
Availability: SAE

HS-019 447

EMISSIONS AND FUEL ECONOMY TEST METHODS AND PROCEDURES FOR LIGHT DUTY MOTOR VEHICLES--A CRITIQUE

A critique of emissions and fuel economy test methods and procedures for light-duty motor vehicles is presented, emphasizing the statistical variability of CVS-CH driving cycle exhaust emission tests and the relative magnitudes of various factors affecting errors encountered during the tests. In addition, questions concerning the effect of ambient temperature on exhaust emissions, data relating to the effectiveness of present evaporative hydrocarbon (HC) emission test methods and procedures, critical elements in any standardized fuel economy test method and procedure, and data associated with the statistical variability of present fuel economy measurements are considered. Critical elements in standardized emissions and fuel economy test methods and procedures are given as: representative standard driving cycle or cycles; method to determine exhaust emissions produced and mass or volume of fuel consumed in the distance traveled during the test; procedure for simulating vehicular loads enountered during the course of the driving cycle; and means of estimating the magnitude and effects of various factors affecting test results. The driving cycle associated with the CVS-CH test method, the urban dynamometer driving cycle (UDDS), was developed to simulate driving patterns in an urban environment. A special project to determine average driving cycles in five major metropolitan areas for use in evaluating the adequacy of the UDDS as an urban driving cycle has concluded that the CVS-CH test cycle is sufficiently accurate to represent urban driving patterns for purposes of determining light-duty motor vehicle exhaust emissions and for determining vehicular fuel economy, but an additional driving cycle is needed to represent highway driving fuel economy. Variations in barometric pressure, fluctuations in test cell temperature and humidity, and systematic errors between laboratories produce varying estimates of exhaust emissions, and conflicting results for the measurement of HC emissions indicate that an accurate test method and procedure for measuring HC emissions needs to be developed and implemented. The SHED test procedure is recommended for evaluation for this purpose. Either the carbon mass balance method or the direct measurement of the mass or volume of fuel consumed during the CVS-CH driving cycle can be employed to obtain accurate measurements of fuel consumption. Improved measurements of fuel economy can be obtained by incorporating a cold-start phase in the CVS-CH urban cycle, using chassis dynamometers with suitably fine inertia-weight controls for urban driving cycles where inertia forces and idle conditions rather than road loads dominate fuel consumption, and considering aerodynamic drag characteristics of the vehicle on a highway cycle.

by David Milks; Richard A. Matula
Drexel Univ., Mechanical Engineering and Mechanics Dept.
Rept. No. SAE-760141; 1976; 15p 37refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 448

EFFECTS OF PRESSURE VARIATIONS AND COMBUSTION DURATION ON THE EMISSION OF HYDROCARBONS AND NITRIC OXIDE

Experiments were conducted to study effects of pressure variations and combustion duration on the emission of hydrocarbons (HC) and nitric oxide (NO). The experiments were conducted on a single-cylinder, variable compression ratio, spark-ignition engine, with hemispherical combustion chamber and four spark-plug holes so that the mixture could be ignited at either one of these locations or at more than one location simultaneously. Two spark-plug holes were 14mm diameter and two were 18mm diameter, using the latter holes

for either single or simultaneous ignition, with spark discharge in the latter case synchronized by external electronics. A water-cooled pressure transducer was installed in one of the 14mm holes to measure instantaneous pressure changes in the combustion chamber, the output in conjunction with a charge amplifier being displayed on a storage oscilloscope along with the crank angle trace obtained with a magnetic pick-up. The remaining spark-plug hole was used to determine flame travel time at different points for various mixture strengths and operating conditions. Exhaust gas was analyzed by using non-dispersive infrared gas analyzers which were calibrated with standard samples in the range of interest. Exhaust gas was analyzed for NO, HC, carbon monoxide (CO), carbon dioxide (CO2), and oxygen (O2) after the engine had attained steady state for a given operating condition. Results show that variations in combustion duration interval change the pressure history developed in the combustion chamber and have the effect of changing NO emissions. Shorter combustion duration achieved by dual flame propagation increases the maximum pressure, the rate of pressure rise, and the time required for maximum pressure to occur in the chamber, and the effect of maximum pressure on increasing the NO emission is comparable to that caused by the other two effects. In this study substantial difference appeared due to this phenomenon in the lean mixture range, while small differences were exhibited in the rich mixture range. Dual ignition also has some influence on HC emission; it was found to be lower with dual ignition than with single ignition when the flame initiation point was located away from the exhaust port but not as low as when the spark plug was located near the exhaust valve. This was particularly evident when the engine was run on lean mixutes. Results of the study suggest that lean mixture engine operation as a means of conserving fuel may be simultaneously increasing pollutant emissions.

by K. S. Varde; G. G. Lucas
University of Michigan; Univ. of Technology, United Kingdom
Rept. No. SAE-760142; 1976; 16p 8refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE
1975; 1,222p
For abstract see summary HS-016 733.
Availability: Corporate author

HS-019 450

PERSONALITY TRAITS AND THEIR RELATIONSHIP TO TRAFFIC VIOLATIONS

The correlation between traffic violations and personality types was studied among enlisted personnel at a midwestern U.S. Air Force base. Subjects were divided into three groups: chronic offenders numbered 18; occasional offenders numbered 52; and non-offenders numbered 33. Subjects were Air Force enlisted males, ranging in age from 18 to 34 years, and averaging around 21 years. Three tests were administered to the subjects (Sixteen Personality Factor Questionnaire, Motivational Analysis Test, and Tension Reduction Test) and results were compared with data from their previous driving records. Results showed that the occasional offenders (one or two moving violations) were more emotionally stable than the non-offenders and the chronic offenders (three or more moving violations in the preceding two years). Discriminant analysis showed significant differences between the personality characteristics of the occasional offender and the other two groups, but none between the chronic offender and the non-offender. The personality characteristics of the chronic offender resembled those of Zelhart's alcoholic offender and Dunbar's accident prone individual (more experimenting, abstract thinkers, assertive, tension-seeking, tender minded, and suspicious). Non-offenders were shrewd, had high tension with respect to parents, had a high desire to reduce tension, a high desire to avoid tension, and high desire to be tough minded. Occasional offenders were more forthright, conservative, concrete, humble, trusting, and showed low tension. Additional research using a more heterogeneous sample might make possible the identification of the high frequency traffic violator by means of personality characteristics measured after his first offense.

by T. D. Brown
Publ: Perceptual and Motor Skills v42 n2 p467-70 (Apr 1976)
1976; 8refs
Availability: See publication

HS-019 451

RESTRAINT SYSTEMS FOR THE PREVENTION OF INJURY TO CHILDREN IN AUTOMOBILE ACCIDENTS

From 1970 through 1974 a series of studies was performed in a large population of infants who attended a well child clinic at a hospital in Tacoma, Washington, to determine the types of vehicular child restraint systems being used and the effect of several different educational approaches to influence parents to use safe restraint systems for transport of their infants and young children in motor vehicles. Emphasis was placed on the use of restraints for children in vehicles because of the high rate of death for children in highway accidents (6,122 such deaths occurring in the U.S. in 1973). Parents of 100 infants ranging in age from nine to twelve months old were surveyed on the type of restraints used. Results showed 62 used either no restraint or restraint systems that were considered unsafe, and 38 used car seats of some type (some of which were ascertained to be more effective than others). These results encouraged the implementation of an educational program on child restraint systems for parents of children coming to the clinic. Parents of 500 infants who came to the clinic with the child at age four weeks were divided randomly into small groups of 12 to 20, stimulated educationally in a variety of ways, and then reassembled into five groups of 100 each to evaluate the effect of the stimulus treatments provided. The five groups were designated as A (received no stimulus), B (exposed to a display in the clinic), C (exposed to the clinic display and handed a pamphlet when they checked into the clinic), D (saw the display and the clinic nurse spent one to two minutes encouraging them to take a pamphlet, read it, and obtain a GM Infant Carrier), and E (saw the display and were encouraged by a physician for from one to five minutes to read the pamphlet and to obtain a GM Infant Carrier). Results showed that personal recommendations by either a nurse or a physician at the four-week visit in the well child clinic increased parent compliance by twice that of other technique by the eighth week of life. Of the infants who were safely restrained at eight weeks of age, 96% were still in relatively safe restraint systems at 9-12 months of age. The effect of various educational stimuli resulted in overall compliance rate at nine to twelve months of 74%-88% compared with a presturdy rate of 38%. It is concluded that compliance with use of restraint systems for children may be improved by parent education in the early postnatal period. Multiapproach educational programs that involve the physician and/or nurse in the early

postnatal period are effective in influencing parents to obtain and use safer restraint systems.

by Robert G. Scherz
Publ: American Journal of Public Health v66 n5 p451-6 (May 1976)
1976; 21refs
Availability: See publication

HS-019 452

U.S. DEPARTMENT OF TRANSPORTATION, ANNUAL REPORT (9TH). FISCAL YEAR 1975

The Department of Transportation's fiscal year 1975 activities are summarized. Official responsibilities include the coordinated and effective administration of federal transportation programs and the development of national transportation policies and programs conducive to the provision of fast, safe, efficient, and convenient transportation at the lowest possible cost. Detailed progress reports are also included from the Office of the Secretary, United States Coast Guard, Federal Aviation Administration, Federal Highway Administration, Federal Railroad Administration, National Highway Traffic Safety Administration, Urban Mass Transportation Administration, and the Saint Lawrence Seaway Development Corporation. During fiscal year 1975, the Secretary was developing a statement of national transportation policy to be issued in fiscal year 1976. The Department also continued a major reappraisal of the effects of federal economic regulation of the transportation industry, concluding that many existing economic regulations result in inefficient use of equipment, limited service to users, and unnecessarily high costs, with particular attention to U.S. international air carriers. Research activities pursued during the year focused on auto energy efficiency, noise abatement, tunneling, aircraft wake turbulence, and techniques for analysis and control of transportation systems. Several actions were taken to reduce transportation energy consumption, including establishing a program to monitor compliance with the 55 mph speed limit, developing plans for two nationwide carpool promotion programs, and reaching voluntary agreement with the automobile industry to achieve a 40% increase in auto fuel economy by 1980. Maritime activities were concerned with keeping the Great Lakes open for navigation throughout the winter, monitoring icebergs in the North Atlantic shipping lanes, seizure of 19 foreign vessels for violation of U.S. fishing agreements, installation of vessel traffic systems, development and regulation of ports, shipboard environmental protection, and ship safety standards enforcement. During fiscal year 1975, the operating cash position of the bankrupt northeastern U.S. railroads worsened, nonrespondent to the various corrective measures which have been undertaken in recent years (Regional Rail Reorganization Act, evaluations, grants and loans, and engineering studies). Major emphasis during the year was on promoting rail industry safety and efficiency in service. Aviation progress is reported in modernization of the enroute air traffic control system, flight inspection, airman certification, aviation security, and review of aviation safety parameters. Landmark legislation enabling urban mass transportation development has provided funding and program assistance for development of urban mass transit, light rail transit, improved bus configurations, regional effectiveness programs, and regulations for elderly and handicapped transportation services. Major accomplishments with regard to highways and highway safety included highway construction or improvements, highway system management, upgrading hazards, improvement of high hazard highways, increased use of buses and carpools in congested areas, implementing the 55 mph speed limit nationwide, determining effects of increased truck size and weight on present and projected highway systems, protection of the highway environment, highway beautification, improved safety standards for vehicles and vehicle components, establishment and extension of vehicle safety defect recall campaigns, and development of safety improved vehicles. An appendix containing tables and figures describing transportation facilities, statistics, programs, and employees is also included.

Department of Transportation, Washington, D.C. 20590
Rept. No. AR-9; 1976; 73p
Availability: Corporate author

HS-019 453

AUTOMOTIVE DESIGN ANALYSIS PANEL OF THE TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980. REPORT

An analysis of automotive design relative to motor vehicle goals beyond 1980 relates user-established requirements of auto size/roominess and performance/acceleration to federally established emission and safety requirements. The analysis also relates representative technological options available to manufacturers concerning automobile weight and materials, to fuel economy potentially achievable in the 1980's time period. The analysis was conducted at two primary levels of interest: vehicle component level and integrated vehicle level, with some illustrative results for the new car fleet. Of nine auto attributes studied in the analysis (size, performance in acceleration and gradeability, structural technology, engine technology, drivetrain technology, emission standards, safety standards, fuel economy, and cost), two (fuel economy and cost), are treated as dependent variables. Auto sizes considered were the functional equivalents of six-passenger, five-passenger, and four-passenger cars; performance (acceleration) levels evaluated were 11.12 seconds, 14-15 seconds, and 20-21 seconds for acceleration to 60 mph, corresponding to horsepower to vehicle test weight ratios of .04, .03, and .02 horsepower per pound, respectively. Three emission control levels were considered: current (1975-1976) Federal standards for exhaust emissions of hydrocarbons, carbon monoxide, and oxides of nitrogen (1.5/15/3.1 gm/miles) and the progressively stricter standards of .41/3.4/2.0 and .41/3.4/.4, respectively. Two safety levels were designated (as realized in current auto design and as potentially realizable in 40 mph crashworthiness capability and anti-lock brakes). Vehicle configuration (auto structure and components) was studied in three levels of curb weight: current; weight-conscious; and innovative (substituting aluminum for steel/iron in relatively low risk components). Alternative engines were selected for analysis within the analytical constraints: the current Otto-cycle engine; the top performing 1975 engine; a lightweight diesel engine; and the Stirling engine. Selections for drivetrains studied were described as current and upgraded (more gears and a lock-up clutch in the torque converter on automatic transmissions). Effects of emission standards upon fuel economy were indicated by the use of analytical ranges. Results of the analysis show that within an uncertainty band of a few miles per gallon, due to the impact of still unsettled emission and safety requirements, the new car fleet average fuel economy can be increased by up to 100% from current levels (about 15.6 mpg) without changes in current fleet mix and without changes in passenger or baggage volume, given sufficient time and efforts to accomplish the necessary development. It appears technically possible for

such an increase in fuel economy to be achieved in the 1980's by combinations of the following actions: reduction of nonfunctional weight and auto redesign to obtain more efficient utilization of auto structure and components; reduction of the inefficiencies in today's internal combustion engines; replacement of the Otto-cycle engine by a lightweight diesel or by other alternative engines; upgrading of the current drivetrain for more efficient utilization of engines; increasing the proportion of lightweight materials such as aluminum and plastics in vehicle structures and components; and increasing the effective efficiency of engines by using smaller engines (thus reducing horsepower to weight ratio and consequently the vehicle acceleration performance).

Automotive Design Analysis Panel, Task Force on Motor Vehicle Goals Beyond 1980
1976; 351p 36refs
Availability: Reference copy only

HS-019 454

AUTOMOBILE EMISSION CONTROL--THE CURRENT STATUS AND DEVELOPMENT TRENDS AS OF MARCH 1976. A REPORT TO THE ADMINISTRATOR, U.S. ENVIRONMENTAL PROTECTION AGENCY

A summary and evaluation of the development programs of automobile manufacturers and other organizations involved in the development of automobile emission control technology is presented, concentrating on the 1977 model year and the post-1977 (1978-1980) time period. Data studied were reported by manufacturers relating to state-of-the-art around the end of 1975, 1975 and 1976 Environmental Protection Agency (EPA) certification results, 1977 Part I applications for EPA certification, and a review of technical literature. Manufacturers report a slowdown in development of technology relating to emission control, caused by uncertainty about future emission standards and passage of the Energy Policy and Conservation Act (PL94-163). The uncertainty about future regulation of emissions has led to increased research, development, design, and production investments in an effort to comply with as yet unknown standards. Also, the manufacturers' primary emphasis is now on fuel economy, not solely on emissions, thus complicating further the pre-market investment. New regulatory requirements are continuing to appear to further slow the technology and manufacturing process. It is estimated that the earliest that the statutory standards for 1978 emissions (0.41 grams per mile hydrocarbons (HC), 3.4 grams per mile carbon monoxide (CO), and 0.4 grams per mile oxides of nitrogen (NOx) can be met is model year 1980, due to time, budget, and manpower limitations and the dual commitment to fuel economy and emissions reduction. The technical feasibility of meeting stated emission standards for model year 1977 is acknowledged for both Federal and California requirements, but differences between Federal and California protocols for determining compliance of 50,000 mile durability vehicles may affect the numerical extent of compliance possible. In the 1978-1979 time frame, meeting standards of 0.41 HC, 3.4 CO, and 2.0 NOx, nationwide, can be projected for about 47-80% of the population without a catalyst change and 64-100% with a catalyst change. The catalyst change approach is seen to be more attractive from the standpoint of fuel economy or from individual manufacturers' technological level, and regulations which do not permit catalyst replacement or service during the 50,000 mile useful life will generally delay the time at which most manufacturers will be able to meet future emission standards. HC control continues to be the most common emission control problem for most manufacturers at any future emission level, especially in relation to fuel economy parameters. Significant developments and trends in emission control technology are identified as: work on the three-way catalyst, specialized NOx catalysts, revised certification fuel specifications, use of electronic controls, improved warm-up control and heat conservation, emphasis on advanced fuel metering, research on a lead tolerant catalyst system, increased interest in diesel engines, and research on reactant emissions control. Data on industry status and on individual manufacturers (including foreign) are provided to illustrate the automobile emission control situation. Appendices illustrate the manufacturer survey material and discuss the potential benefits of improving cold start emission performance using a catalyst.

Office of Mobile Source Air Pollution Control, Emission Control Technology Div., Technology Assessment and Evaluation Branch
1976; 294p 30refs
Availability: Corporate author

HS-019 455

FEDERAL SUPPORT FOR THE DEVELOPMENT OF ALTERNATIVE AUTOMOTIVE POWER SYSTEMS. THE GENERAL ISSUE AND THE STIRLING, DIESEL, AND ELECTRIC CASES

The issue oF federal support for the development of alternative automotive power systems is examined by studying programs whose purpose is to advance the technology with the ultimate goal that the new power systems would be incorporated into substantial numbers of new passenger cars. An assumption is made that the three largest automobile manufacturers in the U.S. (Ford, General Motors, and Chrysler Corp.) behave in a manner which reflects their managements' self-interests (market share and profits), which are in various ways, different from the interests of society as a whole (low cost, reliability, fuel conservations, and ecology) and that government interventions in the automobile market should be aimed at attaining a more socially optimal behavior of the automotive sector. This could be accomplished by arranging a better alignment of the manufacturers' self-interests with those of society, by influencing other firms in the automotive market, or through direct government activity. Specific examination of how the government might perform this function by supporting research and development on alternative power plants is reported. Three specific technologies are analyzed in detail as representative of the three general classes of alternative power systems: the Stirling engine(advanced heat engines); the diesel engine (not too dissimilar from the internal combustion engine); and the electric vehicle (with operating features and societal impacts substantially different from those of other engines). The time frame of interest (1980's and 1990's) is considered without the effects of other government interventions in the market, such as changes in environmental or fuel economy regulations. A descriptive model for the process of technology development and production (TD&P) is developed, consisting of sequential stages of development or productive activity and intervening decisions to advance/continue/terminate an evolving system among the stages. A rational role for Federal government support of alternative automotive power plant research and development is suggested. Three role criteria are listed: the goal for such support programs should be reduced social life cycle cost of automobile operation while meeting long-term emissions standards and treating other non-

jects should be evaluated by a cost-benefit analysis; and design of government programs must be carefully tailored to the particular technology, its status in industry, and reasons for that status at any given time. Conclusions with regard to the Stirling, diesel, and electric power plants qualifying under these criteria for government development support are as follows: government investment in Stirling engine development on the order of $100 to $200 million over five to ten years is justified; government support of diesel engine technology should be concentrated on assisting industry to assess diesel pollutant emissions potential as compared to conventional internal combustion engines; and government support of battery electric vehicle technology is contraindicated. It is concluded that government support of alternative power plant research and development is justified, with best results obtainable through selective support of attractive alternatives in cooperation with the large automobile manufacturers.

by Lawrence H. Linden; John B. Heywood; Henry D. Jacoby; Howard Margolis
Massachusetts Inst. of Tech., Energy Lab., Cambridge, Mass.
Contract NSF-EN-44166
Rept. No. MIT-EL-76-001WP; 1976; 207p 109refs
Availability: Corporate author

HS-019 456

FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980. REPORT. VOL. 1. EXECUTIVE SUMMARY. DRAFT

Energy Resources Council, Dept. of Transportation, Washington, D.C. 20590
1976; 34p
For abstract see HS-019 457
Availability: The Assistant Secretary for Systems, Devel. and Technology, U.S. Dept of Transportation, Washington, D.C. 20590

HS-019 457

FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980. REPORT. VOL. 2. TASK FORCE REPORT. DRAFT

A study of motor vehicle fuel economy goals beyond 1980 is reported, based on a study of the relationship between dependence on the automobile in the U.S. economy and lifestyle and the critical situation with regard to availability of petroleum fuels. Objectives of the study were to set forth various actions that can be taken to improve fuel economy of individual automobiles that will be built in the future and to study the implications of taking one or more of such actions, emphasizing the cost-benefit relationship. Motor vehicle fuel economy rather than reduction of motor vehicle miles traveled (VMT) was the focus of the study. To estimate and evaluate the potential motor vehicle improvements relating to fuel economy beyond 1980, the study group selected a broad range of design concepts, simulated the phase-in of these design concepts through production and into the market, and estimated the resulting effects on petroleum consumption, safety, air quality and health, material resources, petroleum resources, consumer costs, auto industry, and national economy. The evaluations resulting are not offered as forecasts, but as explorations of possible development avenues. Two major automobile design characteristics were considered as affecting fuel economy: design concepts were analyzed and simulated through manufacturing to obtain estimates of resource requirements, including time, capital, labor, material, and energy necessary for the manufacture and production of fuel economical motor vehicles. In estimating effects of such improvements in the automobile on fleet fuel consumption, a baseline growth path was assumed for new car sales, sales size mix, and the auto stock, providing projections of car sales, total auto stock, and VMT consistent with the historical evolution of these variables and with expected demographic changes and long-term economic projections, within the range of alternate forecasts of those variables. Effects of time-phased introduction of fuel economical automobiles are estimated, including potential for savings of four million barrels of oil per day by 1995; 40-50% reduction in fuel consumption by 1995, 80-100% improvement in individual auto fuel economy; 80-100% improvement in new car fleet fuel economy with current size mix; economic payback exceeding capital investment necessary to obtain these savings; reductions or prevention of auto deaths and injuries; improvement in ambient air quality through reduction in emissions; savings in the cost of auto transportation; savings in material resources; and a strong future for automotive industries and employment. Achievement of the potential fuel savings projected is seen to be dependent upon successful research and development in efficient and lightweight auto structures, more efficient engines and drivetrains, improved safety systems, and improved emissions control systems. Federal policy implications of the various strategies that might be pursued in meeting national energy, environmental quality, and safety goals with respect to motor vehicles are for continued Federal intervention and regulation.

Energy Resources Council, Dept. of Transportation, Washington, D.C. 20590
1976; 291p 71refs
For summary see HS-019 456.
Availability: The Assistant Secretary for Systems Devel. and Technology, U.S. Dept. of Transportation, Washington, D.C. 20590

HS-019 458

TRAFFIC CONTROL SYSTEMS HANDBOOK

Basic principles for the planning, design, and implementation of traffic control systems for urban streets and freeways is presented. Chapters discuss and illustrate: the historical background and definition of a systems approach; traffic control studies (goals to be achieved for urban street systems and for freeways, types of congestion, factors contributing to congestion); traffic control concepts for both urban street systems and freeways; concepts for surveillance (the monitoring of traffic performance and the monitoring of control systems operations); computer applications; communication concepts; hardware components; traffic detectors; local and central controllers; traffic control display systems; closed circuit television uses; driver information systems; available systems technology; candidate system definition and evaluation; design and implementation; and traffic control systems management and operation. The systems approach is described in terms of the present status of traffic surveillance and control systems, characterized by a wide variation of control technology, equipment, and operations. The field development is complicated presently by the wide range of choice among systems concepts, equipment types, and operations techniques, with ever more sophisticated electronic control systems becoming available for use in planning, designing, and implementing modern

traffic control systems. The systems approach, as related to the materials presented, is summarized as moving from problem definition through analytical solution to mechanization and verification in use of selected materials and techniques for traffic control. In detail, the design and use of traffic control systems proceeds in five stages: establish system requirements through traffic studies directed either at freeway or urban street systems; synthesize to understand and combine system elements according to candidate systems definition, available systems technology, system components, and communication/computer/surveillance/urban streets control/ freeway control concepts; analysis to evaluate and select a system based on a utility/cost analysis; design, installation, and implementation of a traffic control system according to criteria of deliverable services, project management and scheduling, specifications, and plans; and management and evaluation of the systems during operation with the goal of system improvement. It is emphasized that the systems approach incorporates a continually interacting model which is never finished as new concepts, techniques, equipment, and components become available. Appendices present information of freeway origin destination studies, freeway input/output studies, acceleration noise-mean velocity gradients, forms for traffic signal inventory, travel time and delay parameters, measures of quality of traffic service, recommended information sources, cost element checklist, costs associated with freeway ramp metering systems, and reported costs of selected urban street traffic control systems. A glossary and alphabetical index are also supplied.

Federal Hwy. Administration, Office of Devel., Washington, D.C. 20590
Rept. No. IP-76-10 ; 1976; 666p 395refs
Availability: GPO $12.00, Stock No. 050-001-00114-4

HS-019 459

POST LICENSING CONTROL REPORTING AND EVALUATION SYSTEM. VOL. 1. SUMMARY REPORT

by John Magistad; Dan Kadell; Bill Howe
State of California, Dept. of Motor Vehicles
1976; 35p
For abstract, see Vol. 2, HS-019 460.
Availability: Corporate author

HS-019 460

POST LICENSING CONTROL REPORTING AND EVALUATION SYSTEM. VOL. 2. TECHNICAL IMPLEMENTATION REPORT. FINAL REPORT

Evaluation of an ongoing computerized reporting and evaluation system to determine the cost effectiveness of the California Post Licensing Control (PLC) program as applied to the Negligent Operator (Neg Op) component was carried out. The PLC evaluation program is not only an early warning system that can detect deficiencies that may be developing in an accident prevention program, it is also an action oriented system to provide management with feedback on effectiveness of a modified or optimized program. Evaluation findings for the first year are: all Neg Op treatments (Warning Letter, Group Education Meeting, Individual Hearing, and Probation Violator Hearings) were highly effective at reducing convictions; all Neg Op treatments except Group Education Meeting are effective at reducing accidents; and estimate of benefits vs. costs relating to the Neg Op component shows 1,200 accidents prevented with net savings to society of $175,321 to $3,979,942. The range in net savings figures demonstrates the difference in indicated savings under different assumptions used in the cost benefit computations. Results of the Warning Letter treatment are highly cost-beneficial with any of the estimation techniques used, but cost-benefit results for the other treatments are not as consistent depending on the particular cost and benefit estimate used. However, the Individual Hearing treatment was cost-beneficial with most indices used and was by far the most effective treatment on the basis of net accident reduction. Clues to the relative importance of treatment cost, effectiveness, and benefit estimation are provided. Findings relating to the Neg Op component of the PLC evaluation system are: cost-effectiveness results are shown to be sensitive to costs of treatment; there are potential weaknesses in the data base used to develop cost data; use of different estimation techniques in benefit cost ratios has demonstrated the need to better distinguish between fixed and variable costs; lack of significant effect of the Group Education Meeting treatment on accidents has stimulated efforts to design a prototype for an alternative treatment; capability to generate a figure for the total number of accidents saved is demonstrated; a set of alternative cost-benefit calculations to obtain a range of benefit cost ratios has yielded some conclusions with regard to costs; the Individual Hearing is by far the most effective of the treatments evaluated in terms of reducing accidents and convictions and it was also cost-beneficial on four of six cost-benefit indices; and the benefit computations demonstrate the weaknesses of cost-benefit (societal loss) methodology as applied to motor vehicle accidents. A cost benefit function, as modeled in the PLC evaluation system, is used to make allocations to reduce accidents. Future efforts of the PLC system are suggested: determining additive effects realized through sequential treatments; determining accurate costs of treatments for each area; determining if the PLC program is differentially effective in different areas (accidents and/or recidivism); and expanding the capability of the linear programming model to account for changes in the PLC system and for exploring the sensitivity of uncertainties regarding assumptions and estimates.

by John Magistad; Dan Kadell; Bill Howe
State of California, Dept. of Motor Vehicles
1976; 139p 7refs
For summary, see HS-019 459. Rept. for Feb 1975-Feb 1976.
Availability: Corporate author

HS-019 461

DEVELOPMENT OF THE RELATIONSHIP BETWEEN THE POSTED SPEED LIMIT AND ACCIDENTS ON MARYLAND ROADS. FINAL REPORT

A research effort was conducted to study the effect that posted speed limits have on the number of accidents and type of collisions occurring on Maryland roadways. An underlying objective was to discover the relationship between the posted speed limit and the geometric characteristics of Interstate, U.S., and Maryland roads which would enable the Maryland State Highway Administration to project consequences of lower and higher speed limits and to use as a basis upon which requests for posted speed limit changes could be made. The hypothesis which assumed that changes in speed limits would affect both the number of accidents and the type of collisions occurring, was tested through investigating the differences in

types of data were gathered: information relating to accidents and information relating to characteristics of the accident scene. Types of data used and examined included accident report records, road geometric data, average daily traffic, information, and speed data. The common unit of analysis was a road segment whose posted speed, average daily traffic, and road geometry were constant. One hundred and eighty nine such road segments were examined, 57 on U.S. route 50 and 132 on four Interstate roads. Initial investigation of the data was on a segment-by-segment basis, designed to see if there were any differences between pre-1974 and 1974 data. Two accident rates were examined throughout the analysis: accidents per mile and accidents per million vehicle miles. The data show that the average accident rate by both criteria has decreased from pre-1974 to 1974 for road segments studied. Comparison of road segments with increased accident rates and those with decreased accident rates showed no important significant differences among any variables studied for either category of road segment. Likewise, no causal difference in accident rates by type of accident was found due to road geometrics. It is concluded that the analysis did not indicate any first order linear relationship between accidents, speed, and geometric characteristics for the road segments studied. Relative and absolute risk indices were developed for different road characteristics (curves, grades, medians, shoulders) which indicate the effect on accident frequency of changing the posted speed limit. In general, the incidence of accidents does increase with speed, but the interaction of effect of speed increase with other variables is not known. Appendices contain information on data file records and variable descriptions and tables for various types of accidents by road geometry.

by Wolfgang Jackobsberg; Nolan Danchik
Centers for Study, Inc., 354 Hungerford Dr., Rockville, Md. 20850
Contract HPR-PR-1(9)
Rept. No. AW-076-154-046; FHWA-MD-R-76-6; PB-254 253; 1975; 94p 4refs
Rept. for 22 Aug 1974-30 Aug 1975. State contract number AW-154-046.
Availability: NTIS

HS-019 462

THE EFFECTS OF DRIVER COMFORT ON VEHICLE SPEED. FINAL REPORT

Research aimed at determining if there is any correlation between the comfortable speed chosen by the driver and the type of vehicle being driven is reported. Experiments were designed to determine the correlation between vehicular design and speed driven without the aid of a speedometer in three test vehicles. The three vehicles represented a wide range of design characteristics: a sports coupe, a station wagon, and a sports van. Nuisance variables were held constant for 21 male subjects driving the vehicles by conducting them under similar conditions and constraints, and each subject received exactly the same instructions. Each driver drove approximately 30 miles on an Interstate highway with the speedometer covered, attempting individually to find a speed which was comfortable and to maintain it. Subjects were asked at what speed they thought they were traveliing and these estimates were compared with measured speeds. Results indicated a significant difference in the comfortable speeds selected for the test vehicles, showing average speeds between 66.5 mph and 72.75 mph for the three vehicles. Estimates of speeds selected averaged lower than actual speeds by an average of 5.5 mph. Results show that vehicle design characteristics do influence the comfortable or natural speed at which people tend to drive, with the average comfortable speed well above the existing speed limit of 55 mph by around 15 mph (69.94 mph). Results suggest that a driver must constantly monitor his speed by glancing at his speedometer, possibly causing undue stress, irritability, tension, and frustration. It is suggested that if the present speed limit of 55 mph is to be continued, further research is needed in the areas of vehicle design and roadway design to establish a more acceptable interface between inherent vehicle design characteristics and speed limits.

by Charles H. Berry, Jr.
Texas A and M Univ., Safety Engineering Graduate Prog., P.O. Box 6206, Texarkana, Tex. 75501
Rept. No. ITC-02-08-76-406; AD-A026 348 ; 1975; 40p 16refs
Availability: NTIS

HS-019 463

A PROCEDURE FOR THE STATISTICAL ANALYSIS OF VEHICULAR NOISE EMISSION SPECTRA FOR LIMITED SAMPLES

An iterative procedure and an associated computer program for the statistical analysis of vehicular noise emission spectra from a limited data sample are described. By this method the mean noise spectra of a vehicle type and the variance of that mean from noise spectra data collected on multiple samples of the vehicle type can be predicted. An application of this technique in the determination of representative one-third octave band noise spectra for various types of military tactical vehicles has been performed. Seven different military vehicle types, each with five samples, were withdrawn from depots and used for noise emission tests. Each vehicle was basically in new operating condition and was selected at random from available stock. All vehicles were operated according to MIL-STD-1474 procedures for both interior and exterior noise evaluations. For measurement of noise on the vehicle interior, microphones, sound level meters, and associated equipment were calibrated and installed on board the vehicle. Exterior noise measurements were made utilizing data collection procedures specified in SAE J986a and SAE J366b. Analog magnetic type data were recorded of each vehicle test, utilizing a portable instrumentation type recorder and a sound level meter. These data were then fed into a real time one-third octave analyzer, utilizing 34 parallel active filters to store 30 channels of data as well as weighted and unweighted total spectrum levels. These data are all updated continuously and simultaneously as the acoustic signal is input to the analyzer and are available as digital data in the form of a display, a digital printout, or a paper punch tape. Data were thus reduced and interfaced into the computer during the data input portion of the statistical analysis program for each separate vehicle type. The technique selected for combining various sample means was the one-way analysis of variance, providing correct weightings for vehicles with the greater number of tests. Application of the one-way analysis technique to the noise level model yields various parameters needed for analysis, and an iterative procedure is utilized for calculating the desired quantities from equations. Results of the test analysis show that some equations suggested give the best estimate of the true population mean, while others give the best estimate of the population variance for standardization purposes. It is imperative in setting noise level standards by use of the iterative

analysis/computer program technique that more than ten vehicles be tested to yield sufficient comparative data.

by Richard N. Brooke, Jr.
Army Tank-Automotive Devel. Center (PROV), Warren, Mich. 48090
Rept. No. AD-A025 981 ; 1976; 12p 6refs
Availability: NTIS

HS-019 464

OPTIMAL DESIGN FOR SYSTEMS SAFETY USING FAULT TREE ANALYSIS AND DYNAMIC PROGRAMMING

A method is described for finding the optimal design for systems safety and its total cost without explicitly enumerating all possible design alternatives, using fault tree analysis and dynamic programming. It is also shown how optimal cost and design change as the acceptable probability level of an undesirable event (accident) impacting the system changes. Selection of an optimal restraint system for a car is presented and solved by the method as an example. Four configurations of restraint system are postulated: seat belts alone, seat belts with warning system for fastening belts, seat belts with air cushion restraint system, and seat belts with warning system and air cushion restraint system. Other assumptions are made concerning costs, availability, and reliability of seat belt designs, warning systems, impact-sensing devices, air cushion restraint systems, inflating and deflating systems, and level of acceptable rate of failure in system components. Hypothetical cost and probability of failure for the various constraint systems and components are analyzed, giving for each restraint system designated a total cost and probability of occurrence of failure in restraint function. Given the upper bound on probability of occurrence of restraint failure, two objectives are stated: find the design that meets this limit with the lowest total cost and ascertain what reduction in probability of failure occurs with each additional amount invested in the system. The problem is solved by drawing a fault tree of the system for the design that has all the safety devices, finding the Boolean expression of the undesirable event in terms of the end events of the fault tree, writing for each end event the different values that the probability of the end event can have and the cost associated with each probability value, and formulating the mathematical optimization model of the problem to provide its solution. By this method the optimal design configuration for the probability of failure includes: cheapest seat belts, no warning device, most expensive air cushion inflating/deflating system, and two impact-sensing devices only. Using this method the designer can know how much each level of safety will cost, using optimal design for each level, and he can set the level of safety or the probability of failure based on facts. Once the probability is set, the method can be used to find the optimal design for this probability, and the method can be programmed for computer. Limitations of the method are its consideration of only one failure, and dependence of end event functions in the fault tree analysis.

by Ferydoon Kianfar
Publ: Journal of Safety Research v8 n3 p126-35 (Sep 1976)

HS-019 465

PER CAPITA ALCOHOL CONSUMPTION, LIVER CIRRHOSIS DEATH RATES, AND DRINKING AND DRIVING

Data establishing a close positive relationship between per capita alcohol consumption and liver cirrhosis death rates were the basis of a hypothesis that positive correlations would also exist between per capita consumption and liver cirrhosis deaths in a given area and the proportion of all drivers with positive blood alcohol concentrations (BAC), the mean BAC of drivers, and the proportion of drivers with BAC greater than .10%. Data from drinking driver surveys in five countries, a Canadian province, and two U.S. states were studied. Results showed a significant positive relationship only between per capita consumption and liver cirrhosis death rates and did not support the hypothesis that BACs in drivers are related to alcohol consumption or liver cirrhosis deaths. Several possible reasons for this result are suggested, including too short or too biased statistical series, drinking drivers may have lost their driving licenses or cars, people may be more cautious about driving after drinking than thought in high consumption areas, or high consumption areas may have stricter laws or better enforcement against drinking-driving. It appears, however, that drinking in the general population and in the driving population are not significantly positively related in the areas surveyed. Thus, efforts to reduce per capita consumption my not be effective in reducing the level of drinking and driving.

by Reginald G. Smart
Publ: Journal of Safety Research v8 n3 p112-5 (Sep 1976)
1976; 10refs
Availability: See publication

HS-019 466

DRIVER RECORD EVALUATION OF A DRINKING DRIVER REHABILITATION PROGRAM

A driver record evaluation was conducted as a part of the Nassau County (New York) Alcohol Safety Action Project driver rehabilitation program for convicted driving while intoxicated/driving while ability impaired-alcohol (DWI/DWAI) offenders from February 1971 until June 1973. During this period, 2,805 drivers were invited to attend the rehabilitation program (experimental group) and 2,660 drivers were not invited (control group). Assignment to invited and noninvited were monitored through the New York State Department of Motor Vehicles. The results showed no difference between invited and noninvited groups in terms of number of DWI/DWAI recidivists. The invited group had more drivers involved in reported motor vehicle accidents than the noninvited group. This result was apparently due to the fact that invited drivers who participated in the program were not subject to license suspension/revocation, and may have experienced greater driving exposure. No difference was found between the groups in terms of nonalcohol conviction involvement. It is concluded that other programs of rehabilitation aimed toward preventing recidivism of DWI/DWAI should be evaluated in a similar controlled procedure in order to identify more successful rehabilitation program elements and structures which

oroduce modified drinking/driving behavior or improved mea-
ures of public health.

by David F. Preusser; Robert G. Ulmer; James R. Adams
Publ: Journal of Safety Research v8 n3 p98-105 (Sep 1976)
1976; 7refs
Based, in part, on the evaluation of the Nassau County
Alcohol Safety Action Project performed under Contract
DOT-FH-11-7547.
Availability: See publication

HS-019 467

DESIGN FOR COACH SAFETY AND OTHER NEEDS

Standards for public service vehicle safety are discussed from the aspects of passenger safety, legal requirements, safety parameters, and economic constraints. Economic Commission for Europe (ECE) Regulation 36 is described as it applies to the safety and design for Class I (city), Class II (interurban/rural), and Class III (luxury) single deck buses. Little or no design improvements in seat spacing, escape hatch size and operation, emergency exit provision, and door dimension are required, but significant changes are designated regarding roof strength, waist rail strength, the design of roof pillars, methods for testing structures, isolation of electrical systems, and improvements in braking systems. Brake systems are required to have dual circuitry with failure warning systems, maximum brake response times, downhill performance limits, and possibly, in the future, a third braking system or retarder. Retarder systems of the electromagnetic Telma type, installed around the propshaft just ahead of the differential, are being considered, as well as progressive hand or foot switching or engine brake. Besides regional adaptation problems, such as the routine furnishment of retarders for Swiss buses due to the high proportion of long downhill driving, the general bus configuration has offered some specific construction problems. The problem of providing for volume production has been met by development of monocoque construction processes with initially high tooling costs but gains in volume of production and by use of integral construction processes to effect weight reduction. In all bus construction, there are problems associated with styling and reducing drag, overcoming structural stiffness in the torsional mode in order to obtain efficiency in the suspension system, and development of improved suspension systems. Passenger safety in relation to these design problems and solutions has been investigated in areas of comfort, access, and use, particularly for elderly and handicapped passengers. Two new bus prototypes are described as they relate to these design, construction, and use problems: the Ailsa Truck Assembly Ltd. front-engined semi-integral bus, featuring a low load floor, turbocharged engine, midships Leyland gearbox with electropneumatic auto control, Hamworthy rear axle reduction gears, air brakes, ZF steering, and leaf spring suspension; and the Leyland B15, featuring integral construction, rear transverse engine acting through a fluid coupling to a hydrocyclic gearbox, special fluid coupling aeration, lower load floor, and additional passenger security equipment.

by David Rowlands
Publ: Engineering v216 n8 p556-9 (Aug 1976)
1976; 1ref
Availability: See publication

HS-019 468

THE 55 MPH SPEED LIMIT AND FATALITY REDUCTION IN UTAH

Statistical analysis of Utah's traffic fatality data was performed as a means of studying the possible effect of the 55 mph speed limit on the reduced incidence of traffic fatalities in 1974 and 1975. An analysis of variance technique was used to compare the data on the basis of year effect since the speed limit was enacted in January 1974, thus providing a means of determining whether fatality reductions through 1975 were statistically significant and related to the speed limit or due to other factors. A two-way analysis of variance was performed for total traffic fatalities recorded in Utah in 1971, 1972, and 1973. The same procedure was then performed for 1971, 1972, 1973, and 1974, and for 1971, 1972, 1973, and 1975. The same statistical procedure was repeated for fatalities occurring on less than 55 mph speed limit facilities and for fatalities on 55 mph or higher speed limit facilities, and finally repeated for fatal accidents rather than number of fatalities. Analysis of data by monthly as well as yearly effects was intended to account for weather changes, vehicular volume changes, and vehicle mix by month, and for the fuel shortage, speed limit, and psychological effects on driver behavior by year. The analysis comparing 1971, 1972, and 1973 data showed that the monthly effect was significant, but that the yearly effect was not significant. Results showed that the introduction of conditions of fuel shortage, 55 mph speed limit, and changes in driver attitudes which occurred in 1974 caused a significant reduction in fatalities. While there was a 23% reduction of fatalities on less than 55 mph speed limit roads for both 1974 and 1975 as compared with 1973, it is not statistically significant. When fatalities or fatal accidents for 1971, 1972, 1973 and 1974 were analyzed for roadway facilities on which the 55 mph speed limit was imposed, the reduction is significant and cannot be attributed to chance. The same analysis for 1971, 1972, 1973, and 1975 fatality data again shows the reduction to be significant. The analysis using fatal accidents rather than fatalities gave similar results. It is concluded that the imposition of the 55 mph speed limit and other factors existing in 1974 caused a significant reduction in fatalities where the speed limit was reduced. The reduction in 1975 was also significant, but not as great as in 1974. The factor of the 55 mph speed limit cannot conclusively be isolated in effect from the other factors existing.

by Willard D. Labrum
Publ: Traffic Engineering v46 n9 p13-6 (Sep 1976)
1976; 1ref
Availability: See publication

HS-019 469

SILICONES ARE OPENING NEW DOORS

Silicone materials and products in the automotive industry are used in a variety of forms ranging from fluids, gels, and greases to rubbers and hard plastics, capitalizing on silicone properties of high temperature stability, chemical inertness, water repellency, and strong adhesion. Silicone is being investigated for the creation of a new breed of brake fluids, with the advantage over current brake fluids of being nonhygroscopic and thus improving and extending brake performance. Silicones are also being developed for lubricant applications, including polydisulfide silicone grease for chassis lubrication, valve guides and stems, main bearings, bearings, rocker level bearings, camshafts, oil pump distributor drives, and similar

parts. Silicone lubricants can achieve a risk-free running-in of metal surfaces, and can be used where extreme resistance to chemicals, fuel, or high temperatures is called for. Silicone gels have also been marketed as a potting encapsulant for electronic and electrical devices and as the energy-absorbing agent in some hydraulic shock absorbers, raising shock efficiencies on smaller cars and in rear end units. A silicone room temperature vulcanizing (RTV) compound has also been developed that possessed low viscosity, maintains flexibility, is transparent to allow visual inspection of covered surface, and is the compound used as a replacement for die-cut gaskets, designated as formed in place (FIP) gasket material. The RTV-FIP application has allowed structural flexibility in auto components manufacture and has been successfully demonstrated on valve covers, intake manifold end seals, oil pan gaskets, and cam carrier covers. Elimination of riveting and mechanical joints in such components has also virtually eliminated corrosion arising from their exposure to air and water. One problem noted with the RTV gasket technique is how to compensate for variance in humidity from one time of use to the next in order to make an adequate seal while allowing for processing time. Other potential application areas for silicones are also described: electrical component and wiring jacketing (for temperature and dielectric resistance), adhesives (for bonding automotive body trim pieces), and hoses (for use on heavy duty equipment such as radiators and turbochargers). Versatility, ease of application, economy, long service, low scrappage, and high quality performance are seen as silicone's principal advantages for automotive applications.

by Carl A. Gottesman
Publ: Automotive Industries v155 n4 p29-33 (Sep 1976)
1976
Availability: See publication

HS-019 470

SEAT BELT POTENTIAL STILL UNTAPPED

The design of seat-belt systems as related to their potential for use by the motoring public is reviewed, emphasizing problems of discomfort, inconvenience, and cost to the consumer and redesign and regulatory compliance as related to manufacturing costs. Seat-belt design has evolved continuously since Jan 1964 when the first state laws requiring belts for front outboard passengers went into effect. Lap-belt systems have been joined by shoulder harnesses, warning systems, automatic retractors, harness stowing mechanisms, and a temporary ignition interlock system. Ford has developed a shoulder-belt system which retracts into the seat back at a position considered more comfortable for most passengers and less likely to be unused due to entanglement or inconvenience, but the system has not been installed because a proposed rule relating to seat back heights and seat back strengths would obsolete all existing seat designs and would force obsolescence of new designs in a few years. Also the air bag ruling is still undecided and possibly will be mandated. Fisher Body manufacturers will be introducing two new seat belt systems on 1977 model cars: in the first system one retractor will operate with a window shade mechanism, and in the second system two retractors will be used to permit the user to pull the belt across his body continuously even if motion is interrupted or reversed. The window shade concept may introduce a dangerous amount of belt slack if the webbing is set accidently or deliberately with too much extension prior to setting, and the slack of the shoulder belt could be passed to the lap belt in the single retractor version. A new add-on device for belt retractors is available to ensure good retraction and storage and also a low level of force that is automatically operative when webbing is extracted and retracted. The device, called Comfort Zone, applies the low tension over a chosen range of belt travel, allowing for individual wearer's normal movements without interfering with operation of the main retractor. Other improvements which may be made to current seat belt systems include: changing the level of sensitivity for operation of the emergency lock retractor to a lower level to detect lower levels of braking that might precede a crash, reducing flexibility and elasticity to make the resistance effect closer to average load, and improving seat-belt reminder systems. Public acceptance of seat-belt systems is seen as the key to improving their use rate and thus affording greater vehicle occupant protection, a potential which as yet has not been fully realized.

by Carl A. Gottesman
Publ: Automotive Industries v155 n4 p24-6 (Sep 1976)
1976
Availability: See publication

HS-019 471

THE EFFECT OF LONGITUDINAL FORCE ON BIAS AND RADIAL TIRES

Tests were carried out to compare the effect of longitudinal force on the lateral force and aligning moment produced by a bias and a radial tire for different slip angles. The lateral force-longitudinal force characteristics of both bias and radial tires were very similar at high slip angles, when both tires produced the expected results in the form of arcs of circles of a given radius. At low slip angles, however, the bias tire showed a steady decrease in lateral force as the driving force increased, whereas the lateral force of the radial tire remained substantially constant over a wide range of driving forces. This difference would influence the handling of a vehicle being driven around a corner. Large differences in the aligning moment-longitudinal force characteristics of the bias tire and the radial tire were found. The bias tire exhibited the expected asymmetrical curves, whereas those of the radial tire were nearly symmetrical. These differences occurred because the pressure distributions in the contact patches of the two tires were quite different under the action of lateral and longitudinal forces. The large differences in the aligning moment-longitudinal force characteristics of the two tires could affect the feel received by the driver through his steering wheel, although in most vehicles the steering wheel torque is affected by many other factors besides the aligning moments produced by the front tires. However, in a vehicle with an efficient and direct steering linkage, it is suggested that radial tires would give the driver more reliable information than bias tires about the adhesion between the front tires and the road surface.

by B. D. A. Phillips
Publ: Tire Science and Technology v4 n3 p155-68 (Aug 1976)
1976; 11refs
Availability: See publication

HS-019 472

ON THE INFLATED TIRE PROFILE: INFLATION AND AXIAL COMPRESSION OF A COMPOSITE, INITIALLY CYLINDRICAL MEMBRANE

The analysis for the inflation of bias tires, based on the model of the net of inextensible cords, is reformulated in terms of

bead point coordinates and the cross angle of cords in the initially cylindrical membrane. A simple numerical method of solution is described, and an exact solution in a special case is given. Computations are presented for maximum cord tension, maximum cord-rubber shear stress, and bead tension. These change slowly near the radial case, but rapidly below 70°. Shear stress is lowest while bead tension is highest for the radial tire, and maximum cord tension is quite insensitive to initial cord angle.

by D. W. Nicholson
Publ: Tire Science and Technology v4 n3 p169-79 (Aug 1976)
1976; 4refs
Availability: See publication

HS-019 473

TEMPERATURE RISE TIMES IN PNEUMATIC TIRES

A method for estimating the time necessary to reach an effective temperature-equilibriated state for the rolling tire is dealt with and an idealized model is proposed for the heating of a pneumatic tire. Using known thermal properties of rubber and known heat transfer coefficients, the time to reach thermal equilibrium is estimated. For heat flow purposes, the pneumatic tire is idealized as a plate in which heat is generated internally by cyclic stressing. Beginning at ambient conditions, the temperature in such a plate will rise until it reaches an equilibrium temperature distribution throughout the thickness. The rise times may be obtained by using the transient portions of the analytical solution to this idealized problem. For rubber tires, these rise times are primarily dependent on plate thickness because of the poor thermal conductivity of rubber. They are only weakly dependent on tire velocity so that it is not possible to achieve temperature equilibrium by running the tire faster for shorter periods of time. Using the general thermal properties of rubber, it is found that temperature rise times to thermal equilibrium are proportional to the square of the maximum section thickness.

by S. K. Clark
Publ: Tire Science and Technology v4 n3 p181-9 (Aug 1976)
1976; 6refs
Availability: See publication

HS-019 474

A METHOD FOR COMPUTING THE RADIAL DEFORMATION CHARACTERISTICS OF BELTED TIRES

A method for computing the radial deformation characteristics of belted tires is based on the assumption that the elastic energy of the sidewall can be neglected, thus using the compressed air as the only elastic medium. It is possible to construct a simple relationship between the stress and the reduction of the volume after deformation from the equivalence of the work of the deforming load to the work done on the air content of the tire. Calculations are presented for the volume of the axisymmetrically deformed belted tire, volume of the belted tire under radial load, and deformation characteristics. Experimental verification of the model is made with the 11.00-20 BARUM belted tire and the same tire made by Michelin. The volume of the rim area of the tire does not influence the calculations.

by F. Koutny
Publ: Tire Science and Technology v4 n3 p190-212 (Aug 1976)
1976; 14refs
Availability: See publication

HS-019 475

MATERIALS IN THE '77s

Aluminum, plastic, and high-strength steel producers are in demand for the 1977 model cars as U.S. automakers pare weight and size from their models. Automakers' quest for improved fuel economy to meet consumer demands and 1978 Federal fuel-economy standards are propelling aluminum and plastic usage to record levels. The new '77 models reflect the biggest material changes in automotive history--mostly because of GM's big car downsizing program. This alone has a greater direct effect on consumption of conventional materials than any move ever made by Detroit. Chevrolet Division's 1977 full-size coupes and sedans will lose 1000 lbs. Besides downsizing, Oldsmobile Division is introducing the first all-aluminum passenger car hood in modern times. GM '77 models will have new aluminum hoods, bumper reinforcements, and interior moldings. Ford Motor Co. is expanding its use of cast aluminum wheels and bumpers. New plastic applications include the Firebird's front and rear bumper system which have been redesigned to make better use of plastic. Use of plastic fender liners will increase, as will front seats made of plastic, and the Pinto's new front end will also be made of plastic. High-strength steel will penetrate deeper into such applications as door intrusion beams, bumper bars, suspension brackets, ball joints, license guard reinforcements, bumper brackets, and engine mounts in 1977 since neither aluminum nor plastic stands up well in those areas. Downsizing of big cars plus substitution of lightweight materials in other models will take a greater toll on common, mild steel and cast iron than any other materials. Overall glass use of the '77 models is down slightly due primarily to GM's downsizing operations. Use of zinc die castings will also decline slightly mainly due to gains made by plastic in the headlamp/fender extension areas. Use of copper will also be down. The trend toward greater use of coil-coated steel, galvanized steel, plastic and wax coating, spray-on zinc primers and other special techniques to protect cars from road salts and other corrosive agents will continue in 1977.

by Al Wrigley
Publ: Ward's Auto World v12 n9 p35-40
1976
Availability: See publication

HS-019 476

SAVE THE CHILDREN 0RESTRAINT SYSTEMS0

Research into child restraints and seats for automobiles conducted by the Highway Safety Research Institute (HSRI) is examined. The biggest problem in testing and evaluating child-restraint devices is that there are no standards. The only present standard is a static one; a dynamic test standard is needed--to be applied to crash situations. Live children cannot be used for crash tests so dummies must be used; here again there is no standard for dummies. Child-restraint makers are hesitant to improve their products or design new ones in ca

eventual standards make them obsolete. There are no standards on how children's bodies react to acceleration and deceleration, how they absorb impact, what their tolerances are. There is even confusion as to whether the fact that children's bones are soft is a good thing in an accident situation or a bad thing. In HSRI tests, a $3,000 dummy is used which can show up the systems which don't work at all. Seats should not be purchased unless they are labelled "dynamically tested." Seats come in three major categories: rear-facing, shield type, and harness type. They come in different sizes and should be chosen according to what fits the child. The best seat for infants is the kind in which the infant faces the rear of the car. For older children, the shield type is probably the best providing it fits correctly. Practical considerations when purchasing a seat include making sure it is easy to get the child in and out, easy to clean, and inexpensive (a $20 model can be as good as a $40 model). The Ford Tot-Guard, the Peterson Safety Shell 74 and 75, and the Bobby-Mac Deluxe are especially recommended.

by Fred M. H. Gregory
Publ: Motor Trend v28 n10 p99-102, 104
1976
Availability: See publication

HS-019 477

THE AIR BAG COULD SAVE YOUR LIFE

Private industry with government backing has developed air-bag technology to prevent the loss of 8,800 lives in front and front angle crashes each year. U.S. Transportation Secretary promised a decision by the end of 1976 on requiring automatic crash protection in new cars. In 1975 a DOT hearing voiced support for automatic protection for front-seat occupants. The insurance industry has supported the use of seat belts, and has worked on publicity for their use, but has concluded that no matter what persuasion is used or law is passed not enough people will wear them. Since 1973, 1,800 General Motors and Ford cars have been manufactured with air bags, and driven for 80 million miles. Air bags are now available on some General Motors models. Allstate Insurance Co. operates the largest, private, air-bag equipped fleet, and the company's vice president predicted in 1975 that for economy, cars would get smaller and lighter and if not equipped with passive restraint, more dangerous. Ontario, Canada legislation for seat-belt use was publicly opposed. Federal government interest in air bags led to the proposal that by 1972 they should be fitted to cars. Government and industry negotiations have spanned seven years, and a current DOT proposal would put air bags in 1980 cars. The president for the Insurance Institute for Highway Safety described the way unrestrained bodies are injured by the car interior in a crash, and the way the air bag protects occupants and then deflates. This simple, automatic system is so quick that its deployment was not observed during impact by those that have experienced it in use. The technology has been available since 1968 and could save many lives. A 27-minute color film is available and information on it is obtainable from Harvest A-V, Inc., 309 Fifth Avenue, New York, N.Y. 10016. Comments are invited from the public on air-bag legislation and should be sent to one's Congressman, Senator, or the Secretary of Transportation Re: FMVSS 208. Questions and answers on air bag use in practice are given.

HS-019 478

GOOFS & GOODIES 0NEW CAR MODELS0

Both good and bad features of 1977 model cars are enumerated. GM 77 model cars are shorter, lighter, narrower, and taller than those they replace; yet they seat six adults, drive better, ride better, and get better mileage. Inside, the full-size car instrument panel designs are marred by using overreflective plastic over the clusters. Seat belts give some trouble, and steering wheels on the new full-size cars are left of center. Almost all new Buicks get the 231 V-6 as standard equipment. Ford has restyled its intermediate line which is marred by tight packaging and intermittent cheapness. Ford gets praise, however, for adding a rear sway bar, a bigger front bar, and altered spring and shock rates that provide better handling and suspension. It is still not possible to get reclining seats in subcompacts. Chrysler offers no new models this fall and few appearance changes. Praise for Chrysler is directed toward its Lean Burn electronic spark control system which has a 99.9% reliability record. Besides fuel economy and performance advantages, the Lean Burn system is a consistently reliable emissions beater. American Motors is commended for its Pacer wagon and hatch-back Hornet. AMC is anticipating a large share of the youth market with their "AMX although it is criticized for lack of power and poor design features. Gremlin gets its first facelift in 7 years. AMC is also complimented on its improved reclining seats which are optional in all but the Gremlin, its return to gas cylinders instead of springs on Hornet Sportabout liftgate struts, and continuation of the industry's best warranty program. The next months will see new front-drive small cars from Ford, Chrysler, and AMC.

by Gary Witzenburg
Publ: Ward's Auto World v12 n9 p44-6, 49, 51, 53 (Sep 1976)
1976
Availability: See publication

HS-019 479

SELF-CONDITIONING TRANSDUCERS

When strain gage signals placed directly on long data lines are received by remote processing systems, they may be so attenuated, distorted, and superimposed with noise that they no longer represent the parameter being measured. A typical strain gage transducer is shown diagrammatically and described. Two feasible approaches for signal conditioning employ voltage to voltage amplifiers (VVA's) or voltage to current (VVC's), and typical configurations are described and diagrams given. Temperature drift slewing response, and other nonlinearities in VVA circuits are essentially those inherent in the instrumentation amplifier or strain gage elements of the transducer itself and do not appreciably affect the quality of signals generated. Current VCA circuits may exhibit types of nonlinearities in amplitude and frequency response of the output signal, temperature variation being the principal cause. Further design improvements and high resistance transducers will help to overcome present VCA circuit limitations, so that designers can take full advantage of the reduced noise level and wire savings they provide. Several VVA circuits now available provide high frequency response, high signal level

transducers, the VVA offers a simpler approach at the present.

by D. J. Ray
Publ: Instrumentation Technology v23 n9 p69-73 (Sep 1976)
1976; 4refs
Availability: See publication

HS-019 480

HONEYCOMB AUTO EXHAUST CATALYSTS CONTAINING COPPER CHROMITE AND PALLADIUM

This work was undertaken with a view to reducing automobile catalyst costs by lowering or eliminating the noble-metal content and substituting a base-metal catalyst. A copper chromite ZrO2 honeycomb catalyst was evaluated in the laboratory and on vehicles. When 650-850 g of this catalyst is dispersed on two honeycombs and used to catalytically treat the exhaust of a 4,500 lb, 400 cu. in. Torino, the percentage of carbon monoxide and hydrocarbons during the Federal Test Procedure are close to, but less than, that produced by present noble-metal production catalysts. The total active catalysts surface area available with copper chromite ZRO2 catalyst is somewhat marginal and this leads to pronounced susceptibility to lead deactivation during durability even at very low lead levels if the peak catalyst operating temperature is high (900° C). It is desirable to operate below 700-750° C. Catalyst operating temperatures greater than 550°-600° C are necessary to suppress sulfur deactivation without special operating procedures so that this leaves only a narrow temperature range of operation if the catalyst activity is to be preserved. Catalysts containing a low level of palladium appear to offer a competitive alternate to the use of a high catalyst loading base-metal catalyst. The problem of a limited total active catalyst surface area and susceptibility to lead are still present but other constraints are eased. The key to the successful vehicle use of either copper chromite catalysts or catalysts with low palladium contents is low peak temperatures during use and the use of low-lead gasoline.

by J. T. Kummer; Y. Yao; D. McKee
Ford Motor Co.
Rept. No. SAE-760143; 1976; 19p 24refs
Presented at Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.
Availability: SAE

HS-019 481

PROPOSED MODEL FOR MONITORING AND EVALUATING THE OPERATION OF TEN DOT/NIAAA 0NATIONAL INSTITUTE ON ALCOHOL ABUSE AND ALCOHOLISM0 JOINT ALCOHOLISM PROGRAMS, PHASE 1. INTERIM REPORT

The interim report of a study developing and implementing a uniform system for monitoring and evaluating the effectiveness of Alcohol Safety Action Project (ASAP) and Alcoholism Center (AC) referral, treatment, and rehabilitation programs notes unforeseen variations in their organization, practices, and procedures. These variations are greater than had been expected and more significant in terms of uniform evaluation in such areas as presentence investigation, court system procedures, type and length of treatment, and probation requirements. These variations are illustrated in the profile description in Table I and Appendix A. A Field Trip Report Outline is contained in Appendix B. Critical variations occur in the processing of the DWI, the decision criteria at various process junctures, and the organizational relationships between ASAP/AC and their affiliates. A model designed for monitoring the programs is presented focusing upon: the legal and normative background; the setting, structure, and process of organizations, and the problem populations exposed to different treatment modalities. This model calls for baseline pretreatment measures as well as post-treatment measures. The need for cooperation and participation by the various ASAP's and AC's, plus their parent organizations, is cited. The pilot program evaluation will result in a series of program policy recommendations on ASAP/AC interrelationships, ASAP referral and follow-up procedures, the effectiveness of AC treatment and rehabilitation modalities, the environmental conditions possibly affecting program and treatment outcome, and the development of community support for treatment and rehabilitation of drinking drivers and other problem drinkers.

by Jean Lipman-Blumen; Robert J. Campana; Leland H. Towle
Stanford Res. Inst., Menlo Park, Calif. 94025
Contract HEW-OS-72-208
Rept. No. SRI-URU-2042; NIAAA/NCALI-75/24; PB-246 089; 1972; 93p
Phase 2, Final Rept. is HS-019 482.
Availability: NTIS

HS-019 482

DEVELOPMENT OF A PILOT PROGRAM FOR MONITORING AND EVALUATING THE OPERATION OF TEN DOT/NIAAA 0NATIONAL INSTITUTE ON ALCOHOL ABUSE AND ALCOHOLISM0 JOINT ALCOHOLISM PROGRAMS--EVALUATION OF THE ASAP (ALCOHOL SAFETY ACTION PROJECT)/AC 0ALCOHOLISM CENTER0 PROGRAM0 PHASE 2. FINAL REPORT

The results of final analysis and evaluation of ten Alcohol Safety Action Project (ASAP)/Alcoholism Center (AC) projects jointly funded by DOT and DHEW (NIAAA) and the results of a pilot program monitoring system developed and implemented by SRI are presented. Principal input to the final analysis and evaluation was data from routine output reports produced by the Alcoholism Center monitoring system (ASAP/ACMS), special analyses of the ASAP/ACMS data base, information obtained during site visits to the participating pilot program projects, and selected data available through both standard sources and special surveys. This report presents descriptive statistics and narrative material on the ten projects, their activities and operations, and the clients they serve. Much of the client data is presented as totals for all ten projects or is grouped according to the type of countermeasure to which the person was ultimately assigned as a result of his driving while intoxicated (DWI) arrest, diagnosis and evaluation, and disposition by the court. Data on program activities and operations and, where appropriate, on clients are presented and discussed by site. In general, the data show that the ASAP/AC's are a highly productive mechanism for the intervention and treatment of alcohol abusers and problem drinkers. More specifically, DWI's who have a drinking problem seem to be reached earlier than their non-DWI client counterparts, they receive a greater amount of outpatient treatment, and they stay in treatment longer. This is clearly a result of the ability and willingness of the courts to use coercive per-

client change six months after entry into treatment, appears considerably more positive for DWI clients than for non-DWI clients. Examination of program activities and operations shows wide variability, particularly in the ASAP and the judicial process. The ASAP/AC projects also vary widely in size, client characteristics, and community relationships. The degree of cooperation between ASAP's and AC's ranges from almost nonexistent to excellent. Except at two or three sites, participation by the ASAP's in the monitoring system pilot program was nonexistent or poor. As a result, data comparable to that collected on DWI's referred to AC treatment are not available on other DWI's processes by ASAP's, except for those sites. In this respect, the final analyses in the report are severely limited and few meaningful conclusions can be drawn about assignment of individuals to countermeasures other than AC treatment.

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Stanford Res. Inst., Menlo Park, Calif. 94025
Contract HEW-OS-72-208
Rept. No. PB-245 904; 1974; 277p 6refs
Phase 1, Interim Rept. is HS-019 481.
Availability: NTIS

HS-019 483

EVALUATION OF A PROTOTYPE SAFETY WARNING SYSTEM ON THE GULF FREEWAY. INTERIM REPORT

An experimental warning system has operated on the inbound control section of the Gulf Freeway in Houston since 1972. Its purpose is to assist drivers by warning of traffic stoppages on the downside of crest-type vertical curves. Flashing beacons are controlled by computer and are located on three overpasses. The primary measure of effectiveness was accident rate, and additionally a questionaire was administered. The Houston police furnished logs of reported accidents and a 22% reduction occurred in a parallel nine-month period, after installation of the beacons, although the accident trend for other parts of the highway was upward. There was an 89% reduction in secondary accidents. The average daily traffic, however, increased for the analysis period by 7% on the inbound direction. Benefits anticipated were safety, convenience, and reduced delays. The accident reduction is shown to be due to treatment rather than chance, and annual savings are computed at $29,000. An average 340 vehicle hours of delay occur from a peak hour accident; if involved vehicles are removed from the freeway this is reduced to 156 hours. Assuming that 70% of vehicles during the study were removed for investigation and reporting, total annual reduction in delay is 9,082, at a saving computed at $40,850. Installation of the system was $40,100 and maintenance costs are $2,000 annually. The total cost of a new system is estimated at $81,100, with an annual maintenance cost of $3,000. Fifteen questionnaire studies were conducted and 43% of forms returned were from 8 offpeak studies, the remainder from 7 peak studies. Frequency of travel on the freeway was a factor of whether or not the subject was a peak hour traveller. The sign was seen by 94% of the peak hour respondents but only 81% of offpeak respondents admitted seeing it. Alternatively flashing signs attracted drivers' attention. Sign location had similar responses from peak and offpeak respondents. The distance ahead of the traffic block was variously interpreted, as was the slower speed intended by the sign. The majority of respondents thought it generally exposed to the sign under stop-and-go conditions appeared to find the message more credible. The results of the study suggest that the warning system is cost effective for warning of stoppages on the freeway and it reduced total and secondary accidents. A dichotomy between results of accident and questionnaire studies existed, suggesting that the system should be operated at the peak period, but should be cancelled as soon as possible after the cause has subsided.

by Conrad L. Dudek; R. Dale Hutchingson; Gene P. Ritch
Texas A & M Univ., Texas Transportation Inst., College Station, Tex.
Rept. No. TTI-2-18-72-165-13; PB-241 636; RR-165-13; 1974; 54p 6refs
Rept. for Sep 1971-Jul 1974. Sponsored by the Texas Hwy. Dept. in cooperation with Federal Hwy. Administration.
Availability: NTIS

HS-019 484

A REVIEW OF CONTROL STRATEGIES FOR IN-USE VEHICLES. FINAL REPORT

A review was conducted of studies and evaluations made by the Environmental Protection Agency and various state agencies of the technical feasibility, emission reduction effectiveness, and costs associated with implementing various approaches to reducing the emission of air pollutants from automobiles currently in use. These approaches include: inspection/maintenance (I/M) programs; retrofit programs; and the conversion of in-use vehicles to permit the use of gaseous fuels. Emphasis is on providing emission reduction and cost data realized through use of these approaches which may be useful to the various states in evaluating alternative approaches to in-use vehicle emission control as those approaches may be applicable to their particular air quality requirements. Studies conducted using representative fleets of light duty vehicles were used as the basis for comparison of effectiveness, feasibility, and costs of the approaches outlined. The I/M approach is shown to be dependent on the efficiency of voluntary inspection and maintenance of vehicular components and systems affecting emissions as compared to programmed I/M. The actual value of emission reduction possible through I/M is keyed to the failure criteria used in inspection and the means of enforcing maintenance for failed vehicles. Of alternative approaches within I/M, the emission inspection (testing procedure) using a loaded test cycle is recommended, with controlled (post-1968) vehicles giving the best cost-efficiency in achieved reductions. The retrofit approach can dramatically decrease emissions from both controlled and uncontrolled vehicles using air bleed, lean carburetion, or catalyst equipment. Cost effectiveness for light vehicles retrofitted with such equipment is higher than for heavier vehicles, but the tradeoff value for societal benefits may be used as a factor in assigning cost-benefit ratios which can be obtained with the retrofit (only) or retrofit-O/M combination approach. Present and projected supply and feasibility problems associated with conversion for gaseous fuel operation indicate that this approach is not practical for reducing emissions. No conclusion is stated concerning the best approach to be used, as in-

dividual state and feasibility situations will mandate choices among the choices described.

by J. Meltzer; M. G. Hinton; T. Iura; A. Burke; L. Forrest; W. M. Smalley; F. Augustine
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Contract EPA-68-01-0417
Rept. No. EPA-460/3-74-021; ATR-74(7328)-1; PB-241 768 ; 1974; 236p 82refs
Availability: NTIS

HS-019 485

AN INVESTIGATION OF THE EFFECTS OF CARBON MONOXIDE ON HUMANS IN THE DRIVING TASK. FINAL REPORT

In this two-year study of the effects of carboxyhemoglobin (COHb) produced by carbon monoxide, 40 subjects were tested on the highway by a battery of tests in real driving situations and in laboratory tasks related to driving skills. COHb levels of 0%, 7%, 14%, and 20% were tested, with the results suggesting patterns of performance changes with increased COHb levels. Not all performance measurements were affected by the same level. Laboratory dual tasks, where the subject must perform two tasks simultaneously, exhibited performance changes at lower COHb levels than did more simple tasks, a fact which is significant to the prevalence of accidents in high-demand driver situations. Strong correlation between COHb levels and simple task performances was not observed, possibly because of their familiarity to the subject. Driving performance was categorized into three levels: visual (perception and information acquisition), control (psychomotor), and dynamic response (time-delayed vehicle response). The results suggest that the greatest effects with increased COHb levels occur in the early stages of information processing, visual and psychomotor control being the earliest measurements affected. These are also the most variable measurements, due to a large intrasubject and intersubject variability. In general, no ostensible performance losses were observed with COHb in normal driving tasks, beyond the subtle loss of information acquisition, which could be compounded by fatigue, alcohol, or heavy information processing demands, into gross performance change. A review of the literature is included. Equipment and subject instructions, measurements of COHb levels of freeway drivers, and forms and questionnaires used for the tests are appended.

by F. W. Weir; M. M. Mehta; D. F. Johnson; D. M. Anglen; T. H. Rockwell; D. A. Attwood; G. D. Herrin; R. R. Safford
Ohio State Univ. Res. Foundation, 1314 Kinnear Rd., Columbus, Ohio 43212
Contract CRC-APRAC-CAPM-9-69; EPA-68-02-0329
Rept. No. PB-224 646 ; 1973; 178p 70refs
Availability: NTIS

HS-019 486

AN ANALYSIS OF THE ABANDONED AUTOMOBILE PROBLEM. FINAL REPORT

Quantification of the flow of out of service automobiles through the automotive scrap cycle, with evaluation and recommendation of strategies to mitigate the abandoned automobile problem, is presented. A best estimate of the accumulation of unprocessed vehicles in the U.S. from 1958 to 1970 is 12.7 million, based on an average of estimates for out of service vehicles and processed vehicles less an estimated scrap processor inventory. In urban areas, abandonment rates vary from 0.1% to 1% of vehicles registered, with higher rates associated with the larger cities where vehicle densities approximate 1.4 vehicles per unit of population. The trend toward abandonment is continuing and the backlog of unprocessed vehicles is building up, and countermeasures are clearly required. The auto scrap cycle involves vehicle owners, auto wreckers, scrap processors, state and local officials, and steel users, with dependent variables within the cycle determining the speed and efficiency of its operation. Strategies to mitigate the problem of abandoned automobiles are considered in direct and indirect action categories. Direct action to prevent abandonment is recommended, requiring an owner to provide satisfactory proof of vehicle disposal (or pay a substantial fine) before being allowed to register another vehicle. The indirect actions which are recommended consist primarily of providing incentives in the scrap cycle to encourage the collection and processing of hulks. Guidelines ordinances for solving the abandoned automobile problem are presented, both for prevention of abandonment and for facilitating collection and processing. A dynamic model of the automobile out of service cycle was also developed to demonstrate operations problems and to suggest solutions to such problems. As the model demonstrates, the number of abandoned automobiles can be realistically estimated and the speed of cyclical reuse of scrap can be projected. Certain cycle inputs are highlighted as possible means of reducing the backlog of abandoned vehicles, including changes in depletion allowances, changes in transportation rates to steel mills, and changes in steel making processes. Appendices include a bibliography, survey results, a study plan, and statistical data.

Booz Allen Applied Res., Inc., Bethesda, Md.
Contract EPA-68-03-0046
Rept. No. EPA-670/2-73-013; PB-221 879 ; 1973; 195p 31refs
Availability: NTIS

HS-019 487

AN INTEGRATED METHODOLOGY FOR ESTIMATING DEMAND FOR ESSENTIAL SERVICES WITH AN APPLICATION TO HOSPITAL CARE

The framework of the methodology considers total demand for essential services and associated transportation to be the sum of latent and satisfied demand. The origins of latent demand are indicated by examining the barriers which must be overcome by an individual to satisfy an existing need. The method for estimating satisfied demand begins with census data by enumeration district. Actual usage rates of a service, cross-classified by factors influencing actual usage such as age, sex, race, and income are obtained from national surveys and then applied to the local census data to obtain an estimate of satisfied demand for service by enumeration district. The methodology was used to estimate the satisfied demand for hospital care and was found to be accurate to within 7/10 of 1% for the study region. Total demand for a service may be estimated in a similar fashion by substituting barrier-free usage rates in the above methodology. Latent demand by enumeration district then became the difference between total and satisfied demand. The total transportation associated with a service system is obtained by assigning the demand by enumeration district to the closest facility up to its capacity with spillovers to the next closest facility. Total travel is then calculated using these origin-destination links and the frequency of maps, graphs, diagrams, tables, and charts are presented

which graphically illustrate comparisons made and statistics referred to. Biographical sketches of the authors are appended.

by Ronald Briggs; Wayne T. Enders; James A. Fitzsimmons; Paul Jensen
Council for Advanced Transportation Studies, Univ. of Texas at Austin, Austin, Tex. 78712
Contract DOT-OS-30093
Rept. No. CATS-RR-1; DOT-TST-75-81; PB-241 980 ; 1975; 150p 185refs
Availability: NTIS

HS-019 488

EVALUATION OF PRECHAMBER SPARK IGNITION ENGINE CONCEPTS. FINAL REPORT

Performance, emission, and operational characteristics of prechamber (or divided chamber) spark ignition engine concepts are reviewed, including an analysis and evaluation of the applicability of these concepts to new automotive and stationary engines and retrofit installations. Relative to conventional automotive engines, prechamber engines exhibit very low carbon monoxide emissions accompanied by some reduction in the emission of nitrogen oxides. However, the hydrocarbon emission from prechamber engines is similar to that of conventional engines employing non-catalytic emission control systems, indicating a need for after-treatment devices such as lean thermal reactors or catalytic converters. The fuel consumption of vehicles equipped with prechambers is similar to or slightly better than that of equivalent conventional vehicles at comparable levels of emission control. Prechamber engines under development by the automakers have shown comparable driveability, durability, noise, fuel octane requirements, and power output with conventional engines, with principal advantages in their ability to meet the 1977 Federal emission standards without the use of a catalytic converter. Except for Honda Motor Company, whose prechamber engine is in production, the automotive industry is awaiting the successful completion of their prechamber engine development programs before making decisions regarding the future of these engines. Other factors affecting this decision include the level of future nitrogen oxides emission standards and the degree of success achieved in the development of reliable, low cost nitrogen oxides catalysts for use in conventional engines operating near stoichiometric. Appendices A-C present information on prechamber engine patents, visits and contacts, and units of measure conversions.

by Wolfgang U. Roessler; A. Muraszew
Aerospace Corp., Environmental Programs Group, El Segundo, Calif. 90245
Contract EPA-R-802499-01
Rept. No. PB-241 780; EPA-650/2-75-023; 1975; 240p 88refs
Rept. for Dec 1973-Jan 1975.
Availability: NTIS

HS-019 490

EVALUATION OF ROADWAY SAFETY FEATURES BY COMPUTER SIMULATION--A FINAL REPORT

Reports are presented of nine individual research studies conducted to evaluate the roadway environment by dynamic analysis of the interaction between vehicle, passenger, and roadway. The broad objective of the research was the development full scale tests as basic research tools. Mathematical simulation techniques verified by selected crash tests were used to determine dynamic behavior of automobiles and their occupants when in collision with roadside objects or when traversing highway geometric features such as ditches and sloping culvert grates. The first study documented input requirements for the Highway-Vehicle-Object-Simulation Model (HVOSM), a computer program which was the basic research tool used throughout the study. Basically, the program determined the motions of a single vehicle which occupied prior to and during departures from the roadway for given terrain and/or obstacle configurations. Other studies concerned development of the dynamic occupant mathematical model to be used with the HVOSM to determine occupant dynamic behavior during a given crash; application of the HVOSM to investigate the dynamic behavior of an automobile traversing sloping culvert grates for development of criteria for design of improved grates; use of the HVOSM in combination with crash tests for criteria development on guardrail need on embankments; use of the HVOSM with crash test data to determine impact performance of Texas concrete median barriers; application of the HVOSM to investigate dynamic behavior of an automobile traversing selected curb and median configurations; conduction and comparison of full-scale embankment tests with HVOSM simulations; development of selection criteria for the two most widely used Texas median barriers (concrete and metal beam); and writing an updated user's manual for the Texas Transportation Institute's version of the HVOSM.

by Hayes E. Ross, Jr.
Texas A and M Univ., Texas Transportation Inst., College Station, Tex. 77843
Rept. No. TTI-2-10-69-140-10F; PB-243 008; 1975; 44p 15refs
Rept. for Sep 1968-Feb 1975.
Availability: NTIS

HS-019 491

CONSULTANT REPORT ON AN EVALUATION OF CATALYTIC CONVERTERS FOR CONTROL OF AUTOMOBILE EXHAUST POLLUTANTS

An assessment of the status of catalysts for automotive emissions control and an estimation of future developments in catalytic converters, especially for oxides of nitrogen removal was made. Basic performance parameters of oxidation catalysts are described in terms of thermal reactions and catalyst reactions over platinum, palladium, and ruthenium converting or eliminating carbon monoxide, hydrocarbons, and oxides of nitrogen. Durability data of the various types and designs of catalyst are demonstrated as relative to factors associated with catalyst deactivation (thermal effects, chemical poisons, physical attrition, and pore blockage). Sulfate formation and possible toxicological effects of debris emitted from converters are also evaluated, expressing concern about possible health effects of increased sulfuric acids and effects of catalysts on nonregulated pollutants. Implications are for environmental improvement with broader use of the catalyst systems. Mathematical modeling studies of catalyst system are also reviewed, presenting what is known about the kinetic and mechanisms of the various reactions demonstrated. General conclusions of the review are: ultimate standards for hydrocarbon and carbon monoxide oxidation have been met with current noble-metal catalysts, but nitrogen oxides stan

ble, but fuel mixture precision enabling the single converter oxidation is not currently available; catalyst poisoning by compounds containing lead, bromine, and phosphorus, at certain levels, was demonstrated; a high incidence of catastrophic catalytic failure was shown when exposed to abnormal driving modes; noble metals availability for use in catalytic converters is adequate, but price increases are foreseen, while monolithic supports needed are in adequate production and supply; use of catalyst systems should substantially decrease both gaseous and particulate emissions considered environmentally harmful except for sulfates; and technology for recycling catalyst system materials has not yet been established. It is recommended that continued studies be conducted on poisoning caused by lead motor-mix components with catalyst systems and that environmental data be compiled and analyzed to monitor the effects of use of catalyst systems as the population of catalyst converter equipped cars increases. Appendices list the catalyst companies which were site visited or interviewed and present the survey questions submitted to the companies.

by Joe W. Hightower; John B. Butt; David F. Ollis; Henry Wise
National Res. Council, Com. on Motor Vehicle Emissions, 2101 Constitution Ave., N.W., Washington, D.C. 20418
Contract EPA-68-01-0402
Rept. No. PB-242 092 ; 1974; 126p 97refs
Availability: NTIS

HS-019 492

REPORT BY THE COMMITTEE ON MOTOR VEHICLE EMISSIONS. FINAL REPORT

An evaluation was made of the technological feasibility, cost, and fuel use associated with meeting various light-duty, motor vehicle emissions standards for nitrogen oxides, including the 0.4 gallons per mile statutory standard. The effects of changes from the legislated standards of 0.41 gallons per mile for hydrocarbons and 3.4 gallons per mile for carbon monoxide were to be considered to the extent that such changes would influence the choice of technologies for meeting the nitrogen oxides standards. Emissions control of conventional automobile engines and alternative engines for automobiles are considered. Emissions controls are evaluated in terms of their total impact upon the engine and vehicle and have been evaluated in terms of the following six characteristcs: emissions; fuel economy; the effect of the system upon other performance parameters, such as power, engine size, engine weight, smoothness, noise, fuel flexibility, and safety; manufacturability; reliability and maintenance; and potential improvements which are apparent. Descriptions and evaluations of existing and potential emissions control systems are grouped according to the basic engine types. Current engines include the conventional spark ignition type; near-term, that is engines which are potential candidates for larger scale introduction within a near term period of five years, are the stratified charge, rotary, and diesel; long-term engines, whose large-scale introduction is unlikely within the next five years, include the gas turbine, electric, steam, and Stirling types. Costs of emissions control, manufacturing constraints, and field performance and maintenance are analyzed. Five major elements which influence the costs of emissions control are: capital investments for new technologies; component costs; increased or decreased fuel consumption; increased or decreased maintenance; and risks associated with failure to meet mandated standards with a significant part of production or with vehicles which are not fully acceptable to the consumer. Various automotive fuels are considered, such as unleaded gasoline, alcohol fuels such as straight methanol, methanol-gasoline blends, propanol, and t-butyl, and hydrogen-water fuel mixtures and emulsions. Test methods and procedures for emissions and fuel economy are also considered such as the CVS-CH test which defines a specific driving cycle, weighting factors for the three test phases, and experimental procedures to determine the true mass emissions of 1975 model year and later vehicles. Some of the tables and graphs which are presented illustrate the performance of various engine types, approaches to the control of engine emissions, the average emissions of 1975 certification vehicles, and performance of mixture control systems without catalysts. A glossary of terms used in the report is appended.

National Acad. of Sciences, National Res. Council, 2101 Constitution Ave., N.W., Washington, D.C. 20418
Contract EPA-68-01-0402
Rept. No. PB-242 085 ; 1974; 202p 114refs
Availability: NTIS

HS-019 493

MOTORIST AID SYSTEMS STUDY. COMPREHENSIVE BIBLIOGRAPHY

Annotations to entries in the Motorist Aid Systems Bibliography are presented, covering topic areas of: general motorist aid systems (24 items); state-oriented motorist aid systems (34 items); citizens band radio, state programs (3 items); citizens band radio, general (5 items); courtesy patrols (2 items); other motorist aid system concepts (auto radio adapter, automatic vehicle detection, cable technology, driver aid-information and routing, cooperative motorist systems, single frequency communication system, Loran-C, 911-emergency telephone number, retrolite, self-powered vehicle detector, and Vascar) (16 items); emergency medical services (4 items); and related fields (15 items). State-oriented motorist aid systems included cover California, Connecticut, District of Columbia, Florida, Georgia, Illinois, Iowa, Maryland, Massachusetts, Maine, Michigan, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Texas, and Utah. Related fields covered are road pricing technology, road services, road patrols, hazards detection and removal, freeway surveillance and control, driver characteristics, communication system engineering, tunneling, and highway transportation statistics. Annotations stress evaluation and application of research data according to the current state of the art of motorist aid technology.

by I. J. Fullerton; R. A. Presby
JHK and Associates
Contract DOT-FH-11-8745
Rept. No. Implementation-Package-76-12; 1976; 54p 103refs
Bibliography entries presented are annotations to the Motorist Aid Systems Bibliography, with referent page numbers 239-89.
Availability: Federal Hwy. Administration, Office of Devel.-Implementation Div., Washington, D.C.

HS-019 494

FINAL REPORT TO THE LEGISLATURE OF THE STATE OF CALIFORNIA IN ACCORD WITH RESOLUTION CHAPTER 152--1972 LEGISLATIVE

SESSION (SENATE CONCURRENT RESOLUTION 44--HARMER)

The California Dept. of Motor Vehicles and the Office of Alcohol Program Management, in its study to determine the feasibility of implementing the recommendations of the 1970 Governor's Automobile Accident Study Commission (GAASC), responded to the questions of whether drunken drivers can be classified, who is best suited to perform the classification, and how effective are customized treatment approaches. The evidence indicates that drinkers and drinking drivers can be classified with a moderate degree of validity. There seems to be a slight relationship between driving records and degree of alcohol abuse: problem drinkers having a worse record than social drinkers. The best indicators of problem drinking driving is BAL, the number of prior offenses and alcohol tests such as Michigan Alcohol Screening Test (MAST) and the Mortimer-Filkins (M-F). There is no evidence that classification leads to more effective remedy or control of the drinking driver or that customized rehabilitative treatment based upon this classification is beneficial. Classification should be made by trained nonmedical personnel as the expense of medical advisory boards is not justified and the necessary physicians trained in alcoholism are not available. Evidence suggests that punitive sanctions, especially license suspension, have impact on subsequent driving record or deterrent effects on the general driving population. Based on the results of the study, the following recommendations are proposed: that no customized rehabilitation approach to drunk driver control be adopted State-wide at this time; that no legal sanctions, especially license suspension, be relaxed in favor of medical or rehabilitation approaches, with the possible exception of work-related driving licenses; that drunk driving continue to be viewed as a criminal offense, unrelated to treatment programs; that drunk driving programs be integrated on a State-wide basis by the California Department of Motor Vehicles (DMV), Office of Traffic Safety, Office of Alcohol Program Management (OAPM), or the Administrative Office of the Courts; that BAL be a mandatory requirement on all drunk driving conviction reports to DMV; that drunken driver rehabilitation efforts be periodically reviewed by OAPM and DMV and possible effective programs be identified; that the feasibility of integrating a customized rehabilitation approach with driver's license reinstatement be evaluated; that treatment of drunk drivers be coordinated to improve equivalence of justice or treatment principles; that the existing sanctions against drunk driving not be changed but applied more consistently; that future research projects in this field be conducted by rigorous research design principles; that public drunk arrest (Penal Code 647f) be reinstituted as a reportable offense if classification systems are made operational, as this information is a critical variable in successful classification; that, if administration adjudication of traffic offenses by DMV hearing officers is deemed desirable, drunk driving offenses be included; and that a BAL of .10 or greater should be judged to be a nonrebuttable illegal offense. The OAPM in a covering letter, rejects the concept of treating alcoholism as a disease in the reduction of drunk driving offenses. The Office believes that further studies are needed to evaluate the combined or separate effects of legal sanction or appropriate treatment.

California Dept. of Motor Vehicles, Sacramento, Calif.
1975; 82p 98refs
Availability: Corporate author

HS-019 495

AN EVALUATION OF THE 1974 AND 1975 RESTRAINT SYSTEMS. AN HSRI 0HIGHWAY SAFETY RESEARCH INSTITUTE0 SPECIAL REPORT

In-depth accident investigation programs were conducted to collect data for evaluation of the efficacy of the 1974 and 1975 vehicle restraint systems. Stratified random sampling techniques were used to collect data on 1973, 1974, and 1975 U.S. passenger cars in towaway accidents. After 18 months of field investigation, data were available on 6,729 vehicles and 9,186 outboard front seat occupants. Occupants of 1974 cars used restraints substantially more frequently than occupants of 1973 cars. Use of full restraints by these occupants increased by a factor of eight over their use in 1973 cars. Use of the full restraint in 1975 cars was lower than in 1974 cars, but was still more than seven times as great as in 1973 cars. There was no measurable difference in the incidence of moderate or severe injuries in the three model years studied. Nevertheless, restraint systems in these cars demonstrated a substantial capability to reduce the incidence of moderate or severe injury when they were used. Lap belts alone reduce the probability 27% compared to no restraint. Lap and upper torso belts together reduce the probability 21%, compared to the lap belt alone, and 42% compared to no restraint. It was concluded that restraint systems are more effective in eliminating moderate to severe injuries than they are in preventing minor injuries. The head, face, extremities, and chest regions of restrained occupants are injured less frequently, while their neck, abdominal, and pelvic regions sustain more minor injuries. Full restraints reduce the frequency of occupants sustaining an injury from the steering assembly and front interior, but do not eliminate them. Moderate or severe injuries which can be attributed to the restraint system were extremely rare. Changes in restraint usage rates following the 1974 introduction of the starter/restraint interlock system were also examined, concluding that the inducement to restraint use because of the interlock system was temporary and had largely disappeared by the end of the project. Appendices present information on the field data form, derived damage severity measurement using the collision deformation classification, supplemental tables, candidate control variables, and estimated model parameters.

by Robert E. Scott; Jairus D. Flora; Joseph C. Marsh, 4th
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109
Rept. No. UM-HSRI-76-13; 1976; 177p 9refs
Rept. for Jan 1974-May 1976.
Availability: Corporate author

HS-019 496

ENERGY AND FREIGHT MOVEMENTS

Truck data and performance were studied to assess fuel efficiency in freight transportation in four hypothetical intercity operations and two examples more typical of urban operation. All examples were based on values near the limits of actual operation to illustrate possible ranges and relationships. Intercity freight fuel efficiency was considered in four cases, using a hypothetical semi-trailer truck combination with an empty weight of ten tons and a maximum allowable gross weight of 40 tons or 80,000 pounds, providing a payload capacity of 30 tons. Example one is based on a full load of 30 tons hauled 200 miles via a good Interstate highway, driven empty ten miles through urban traffic to pick up a load of seven tons,

and driven 25 miles back to the original point via Interstate type highways. Example two is the same as one except that two vehicles are used, each returning from a 30 ton load empty. Although one involves only 18.8% empty travel compared to 50% for two, procedure two is 5.5% more fuel efficient according to tonnage shipped per gallon of fuel consumed. Example three is a nearly ideal case, and features full loads available at two points with only a short empty leg, giving 75.6% better efficiency than procedure two. Example four features low tonnage delivered with no empty travel, but results in the lowest efficiency (59.6% of two). Tons shipped is seen to be an effective measure of comparative fuel efficiency only when shipped densities are similar, a shipping density of more than 15 pounds per cubic foot is necessary to achieve an assumed 30 ton payload. In general, the four intercity cases described produce ton-mile and ton-miles-per-gallon values falling in the same relative order as tons-shipped and tons-shipped-per-gallon values. Urban freight fuel efficiency is studied with examples five through seven. The examples show a distribution operation from a warehouse to seven customers, either: picking up their own orders in light trucks; delivering all orders in turn from the warehouse in one medium sized truck; or splitting up deliveries and using three small trucks. Delivery from a warehouse truck or trucks is shown to be more efficient than customer pick-up, unless maximum technology trucks were used by the customers. In addition to density, characteristics of value, perishability, fragility, frequency of shipment, amount to be shipped at one time, total amount to be shipped over a long period, seasonableness, competitive sources, and time value may influence the way things are shipped and considerations of fuel efficiency. Labor input as related to fuel price input may also redistribute efficiency ratings of available freight modes in future analyses.

by Alexander French
Publ: Transportation Journal v16 n1 p26-41 (Fall 1976)
1976; 3refs
Presented at Transportation Research Board, Washington, D.C., Jan 1976.
Availability: See publication

HS-019 497

INTERCITY FREIGHT FUEL UTILIZATION AT LOW PACKAGE DENSITIES--AIRPLANES, EXPRESS TRAINS AND TRUCKS

Several analyses have been published which compare the energy use efficiencies of the various modes of intercity freight transportation, but little or no attention has been given to the characteristics of the freight being carried by the various modes. The impression may have been left that the modes compete in identical markets and that any ton of freight is the same as any other ton of freight. The relationship between energy consumption and freight density, as a commodity characteristic, is explored. Several aspects of modal energy analysis are examined, including the impact of freight density on modal trip energy comparisons. Secondary energy consumptions such as apply to manufacturing and facilities operation are not considered. Modal market data are used to define the field of interest: transportation of low density commodities in airplanes, express trains, and trucks. Modal energy utilization efficiencies are also developed. A critique of two commonly used analysis techniques, gross modal analysis and idealized calculations, are given. U.S. domestic freight movement has grown 67% in annual ton miles from 1947 to 1970, with major growth in truck and pipeline modes. Rail traffic has also increased, but the rail share of the total market has decreased. In later years, air achieved high growth rates, yet by 1970, only 0.2% of the total ton miles were carried by the air mode. Revenue data show that, on the average, the various modes serve different markets according to products and destinations. Freight density distribution data also indicate higher truck and rail freight values than the air mode (two to five times higher, respectively). Pitfalls of modal energy analysis (system and equipment constraints, operational procedures, and data reporting methods) were avoided in gross modal analysis and idealized calculations of the present study by using uniform payload expressions, fuel units, freight package densities, and ranges of performance. In comparing the air, truck, and rail modes on criteria of fuel utilization, freight density, and mileage, results show that express trains are more efficient than the other modes. However, typical trucks are comparable with some trains as is also the belly freight of the aircraft 747-200B. The latter is also competitive with typical trucks. At average air freight density, typical express trains and typical trucks are respectively seven and four times more fuel efficient than air freighters. It is concluded that service of significantly different markets by intercity freight transportation modes precludes the need for modal energy efficiency comparisons to some degree, but further study of freight parameters such as commodity value, trip time requirements, and economic value factors is needed to characterize efficiencies within specific categories of use and need. Statistical material illustrates major textual information.

by R. A. Mays; M. P. Miller; G. J. Schott
Publ: Transportation Journal v16 n1 p52-75 (Fall 1976)
1976; 25refs
Presented at Transportation Res. Board, Washington, D.C., Jan 1976.
Availability: See publication

HS-019 498

AN EXAMINATION OF THE POTENTIAL BENEFITS OF SMALL AUTOMOBILES

An investigation of the potential benefits and disadvantages of small cars was carried out, considering policy alternatives to encourage their use. As one of the available means of improving efficiency of fuel use in the private automobile, decrease in curb weight (and implicitly size) of the automobile was considered in three aspects: how small should a small car be, meant to accomplish optimal fuel efficiency; how do you sell such a car; and what effects would a major shift to such small cars have on environmental and energy considerations. Availability of cars below 2000 lb and those projected for future market entry demonstrate that cars with acceptable performance and comfort which weigh 1500 lb or less can be built, with major market penetration for urban use. Technological considerations for mass production and use of such vehicles indicate that present and projected pollutant emission standards could be met, depending on delays caused by new standards and regulations for scheduling market availability. The major problem visualized with potential development of smaller cars is safety, since their use could lead to a 15% increase in fatalities or serious injuries unless accompanied by the institution of safety measures such as improvement in and more extensive use of passenger restraint systems, improved structural design, and strict enforcement of speed limits. Marketing of the smaller cars could be aided by appeals for fuel economy, a trend toward increased cost and taxation of gasoline, and tax rebate policies to facilitate both design and

production of smaller cars and their purchuase by consumers. Advantages of shifting to smaller cars would include: fuel economy (a major shift to use of such cars by 1977 could save one million barrels of oil per day by 1980); improved traffic conditions; increased traffic capacities of existing roadways; possible reduction in pollutant emissions; and elimination of some parking problems. Disadvantages foreseen are in reduced sales of raw materials and finished products and increased unemployment, but some offsetting effects of these deleterious results have been cited in previous studies (aftermarket sales, greater production volume, and increased sales). Encouragement of small car use in urban transportation is especially recommended, and countermeasures to offset disadvantages discussed are suggested. An appendix presents detailed analysis of required improved passenger compartment configurations.

by L. L. Perini; R. A. Makofski, eds.
Johns Hopkins Univ., Applied Physics Lab., Johns Hopkins Rd., Laurel, Md. 20810
Rept. No. APL/JHU-CP-045; PB-253 233 ; 1976; 107p 50refs
Availability: NTIS

HS-019 499

PERSPECTIVES IN MOTORCYCLE ACCIDENT INVESTIGATION 0UTAH0

From 1969 through 1975 motorcycle registration in Utah increased from 20,700 to 50,934; injuries increased from 454 to 855; and fatalities increased from nine to 21. Throughout 1975, a comprehensive record of Utah's motorcycle safety environment was maintained by sampling a wide variety of the population which directly or indirectly influenced this highway safety area. Analytical tools used were motorcycle accident report forms, driver histories on individuals involved in motorcycle crashes, medical examiner records pertaining to motorcycle fatalities, opinion surveys to measure public knowledge of factors related to motorcycle safety, and roadside surveys to ascertain motorcycle traffic volume and helmet usage. Factors contributing to crash incidence discovered through analysis of the data, included speed, experience and skill, age, violations, location and environmental conditions, driver, vehicle, time and season, manner of collision, and contributing circumstances. The role of driving experience was found most significant, both with respect to motorcycle driving experience and experience in driving the motorcycle involved. Data showed that 85% of cyclists involved in crashes has less than five years of motorcycle driving experience, and 52% of crashes involved drivers with less than two years of motorcycle driving experience. Around 74% of drivers involved in accidents had less than one year of experience on the motorcycle involved. The analysis also showed that the majority of drivers involved in motorcycle accidents were not generally problem drivers. Analysis of other data showed that, as motorcycle size increased from 0 to 799 cubic centimeters, the percentage of accident involvement rose also, and 60% of all crashes took place with a motorcycle over 250 cubic centimeters. The majority of bodily injuries suffered in crashes affected the arms and legs, torso, and head, in descending representation. Speed was ascertained to be the most significant variable in relationship with injuries sustained. It was also with high rates of voluntary and mandatory compliance according to present regulations.

by Robert F. Parenti
Department of Public Safety, Utah Hwy. Safety Div., Denver Bldg., Suite 300, 352 Denver St., Salt Lake City, Utah 84111
1976?; 9p
Availability: Corporate author

HS-019 500

THE FREQUENCY OF ROAD ACCIDENTS 0PT. 10

Two approaches to understanding the mechanism controlling the numbers of road accidents are described. One relates numbers of road fatalities to numbers of motor vehicles in use and the other relates reported road accidents to estimated distances traveled by motor vehicles. Previous studies have shown a rough relationship between the numbers of road fatalities and the number of registered motor vehicles and the population count. Investigation by the writer has demonstrated that the number of fatalities, and hence the number of fatal accidents, increases roughly as the cube root of the number of motor vehicles, that is, much less rapidly than the number of motor vehicles, contrary to expectations, and that the number of road deaths depends on factors in addition to the number of motor vehicles and the population, although these are predominant factors. In view of expectations that single and multi-vehicle accidents would vary with traffic in different ways, separate analyses are made for single vehicle (non-pedestrian) accidents, pedestrian accidents (almost entirely single vehicle), and two vehicle accidents. For Great Britain's statistics, analyses were carried out for all injury accidents reported in various years between 1951 and 1971 and for accidents by time of day in 1965, 1967, 1969, and 1971, omitting accidents involving public service vehicles. Data on injury accidents occurring on state highways of California were also analyzed for comparison purposes. In the single vehicle, non-pedestrian accident category, distances traveled by pedal cyclists, motor cyclists, cars, taxis, and goods vehicles have increased while accident rates fell. In the two vehicle accident category as well, the number of accidents is not generally proportional to distances traveled by types of vehicles involved. Analysis by time of day, however, yields predicted results relating to distances traveled. It is concluded that, to a considerable extent, the number of single vehicle accidents involving any type of vehicle during any daylight hour is proportional to the distance traveled by vehicles of that type during the hour, and the number of collisions between any two categories of vehicle during any daylight hour is proportional to the product of the distances traveled by each type of vehicle during that hour. Discrepancies in the prediction are attributed to other unknown factors or to errors in assumed values of distances traveled.

by Reuben J. Smeed
Publ: Zeitschrift fur Verkehrssicherheit v20 n2 p95-108 (1974) 1974
See HS-018 674 for Part 2.
Availability: See publication

NATIONAL TRANSPORTATION PROBLEMS, APRIL 28-29, 1976

A conference was held which highlighted safety problems and needed transportation safety research identified by DOT modal safety managers. Its aim was also to stimulate university or university/industry teams to respond with research proposals emphasizing multimodal applicability and a systems view, and to provide a forum for university research groups to inform DOT safety managers of promising new directions in transportation safety research and new tools with which to address safety related problems. The conference addressed research requirements for safety in three contexts, using workshop panel techniques: interinstitutional problems of transportation safety; goal setting and planning for transportation safety programs; and DOT information, management, and evaluation systems requirements. Topics for the first panel were interinstitutional problems of Federal-state/local; Federal/industry; Federal/public; and consumer groups. Panel two investigated issues of modifying risk behavior, safety as a social value, and involving citizens in the development of standards as a way of increasing probability of achieving program objectives. The third panel considered requirements for data and analytic tools for management of safety programs. Conference participants generally agreed that research and methodology is needed in specific modal safety problems and in removing barriers for safety promotion, public consideration and involvement is facilitating to safety goals expressed, the current data base for safety program design and management is not adequate or convincing, and intermodal safety analysis is ambiguous compared to what is possible with modal analysis. Common problems described in transportation safety research by university groups concerned: lack of disciplinary focus on safety within the university context; communication weaknesses between DOT and academic researchers; and universities' continuing contractual problems with DOT. Discussants and participants are identified throughout the report, and are listed in an appendix. The guidelines for the conference and identified research requirements are also appended.

by Alan J. Warshawer, ed.
Department of Transportation, Office of Univ. Res. (TST-60), Washington, D.C. 20590
Rept. No. DOT-TST-76-77 ; 1976; 209p
Availability: Office of the Secretary, Office of Safety Affairs and Office of University Research, DOT, Washington, D.C. 20590

HS-019 502

YOUNG ADULTS ON BIKES--AN NSC STUDY

A study on bicycle accidents and usage among young adults was conducted by surveying 1,370 university students who use bicycles. The survey questionnaire contained 118 multiple choice questions on the bicyclist himself, the kind of bicycle used, most recent bicycle use, most serious bicycle accident within the past 12 months or five years, and local bicycling conditions. The study sample was 62% male, and 52% were between the ages of 16 and 20, 40% were between 21 and 25, and 8% were between 26 and 30. More of the subjects owned ten speed bikes (36.8%) than owned 15-speed (1%), five-speed (6.6%), three-speed (25.3%), or one-speed (27%) bikes. The majority of bikes were equipped with hand brakes (62.3%) and regular as opposed to drop-style handlebars (57.1%). Most bikes were equipped with rear reflectors or lights (79.%), but fewer had front lights (37.2%). Survey results also showed that the riders with five or more gears tended to travel more in business areas, on main streets, and in heavy traffic than cyclists with lower-speed bikes. They also travel greater distances and have fewer accidents per 1,000 miles traveled, but more accidents per person and per year. Arms and legs were the parts of the body most often injured (38% each), injury most often resulting from contact with the ground (66%) or bicycle parts (15%). Compared with younger drivers, the young adult cyclists ride less frequently, are more likely to use their bikes in heavy traffic and under adverse weather conditions, and more often have bikes equipped with lights and reflectors. It is concluded that differences in accident patterns between young adults and children riding bicycles reflect differences in their respective exposure patterns.

by Robert B. Overend
Publ: Traffic Safety v76 n10 p22-4, 34-6 (Oct 1976)
1976; 1ref
Availability: See publication

HS-019 503

MOTOR CARRIER ACCIDENT INVESTIGATION. SECO, INC. ACCIDENT--FEBRUARY 18, 1976--WASHINGTON, D.C.

An accident involving a tractor semitrailer combination operated by Seco, Inc., of Marlow Heights, Maryland (referred to as the truck) and an automobile occurred at 6:15 pm on 18 February 1976 at the intersection of Naylor Road, 22nd Street, and Minnesota Avenue, Southeast, Washington, D.C. The truck entered the intersection, collided with the rear of the automobile, overrode the traffic control island and signal support, then left the roadway striking and penetrating a nearby apartment building. The accident resulted in five fatalities, three injuries, and approximately $90,000 property damage. Probable cause was assigned to inattentiveness of the part of the truck driver and a deficient vehicle which was improperly inspected and maintained. Environmental conditions were not ideal (the weather was cloudy with light rain and temperature of 66°, and the accident location was dark with wet pavement), but no major fault was assigned to these. Additional information is given on events preceding the accident (relating to the truck driver and condition of the truck), the accident, and driving records of the two drivers involved. Details of defects found in the truck are given with primary emphasis on brake condition. Violations of the Federal Motor Carrier Safety regulations which were found included: driver traffic violations which had not been reported, failure to investigate driver's employment record, failure to maintain driver qualification file, failure to maintain driving log properly, and failure to inspect and maintain vehicle to insure safe and proper operating condition.

Bureau of Motor Carrier Safety, Federal Hwy. Administration, Washington, D.C. 20590
Rept. No. BMCS-76-2 ; 1976; 15p
Availability: Corporate author

HS-019 505

MODIFYING NEGLIGENT DRIVING BEHAVIOR: EVALUATION OF SELECTED DRIVER IMPROVEMENT TECHNIQUES. FINAL REPORT

Specific criteria for selection as subjects were met by 15,290 drivers. The drivers were randomly assigned to one of eight in-

itial treatments or to an untreated control group, and each subject's driver record was examined for collision and conviction reports during the year after his selection. Treatment groups included: control, warning letter (WL), subject interaction meeting (SIM), leader interaction meeting (LIM), group educational meeting (GEM), driver improvement meeting (DIM), group administrative review (GAR), regular individual hearing (RIH), and experimental individual hearing (EIH). Comparisons were made between each treatment and the control group. When the records of males and females were combined, only persons scheduled for GEM had a collision rate that was significantly lower than the control group, and several other treatments showed a significant reduction in convictions compared to the control group. Because men represented almost 90% of the sample, the rank order of the treatments for men is almost identical to the order for both sexes: GEM treatment produced best results overall. For women only, the results showed that RIH and EIH achieved the best reduction rates. Cost/benefit analysis results indicated that using the GEM treatment method for both sexes would produce a net savings of about 3.4 million dollars per year in California in accident related cost. An analysis was also performed on the effects of a follow-up hearing administered to drivers who continued to accumulate traffic convictions and collisions after their initial treatment. Such follow-up action resulted in further collision reduction except in cases where no initial treatment was administered (controls). The cost/benefit ratio of the GEM program in relation to competing programs is not yet known, but it is concluded that no single countermeasure can be as effective in preventing accidents as more than one countermeasure which have been selectively chosen and evaluated for broad operations application. Recommendations made were: avoid using individual hearings as first contact with male negligent drivers; limit use of reexamination within the educational meeting format to an experimental program until traffic safety implications of the new program can be evaluated; as an interim measure, substitute another type of contact for the combined group meeting and reexamination outside the experimental operation; and quickly call up drivers who continue to violate after their first contact for an individual hearing for action according with established policy. Warning letters used in the study are included.

by William C. Marsh
California State Dept. of Motor Vehicles, Res. and Statistics Section, P.O. Box 1828, Sacramento, Calif. 95809
Rept. No. PB-218 853; CAL-DMV-RSS-71-36 ; 1971; 68p
19refs
Availability: NTIS

HS-801 924

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES VOL. 7, NO. 3

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident, a description of the highway, vehicles, drivers, and occupants involved, a narrative of the sequence of events of the collision including details of the precrash, crash, and postcrash phases, an assessment of injuries and damage, and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

Office of Accident Investigation and Data Analysis, National Hwy. Traffic Safety Administration
1976; 355p
Availability: NTIS

HS-801 925

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES VOL. 7, NO. 4

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident, a description of the highway, vehicles, drivers, and occupants involved, a narrative of the sequence of events of the collision including details of the precrash, crash, and postcrash phases, an assessment of injuries and damage, and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 53 case reports are given.

Office of Accident Investigation and Data Analysis, National Hwy. Traffic Safety Administration
1976; 318p
Availability: NTIS

HS-801 926

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES VOL. 7, NO. 5

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident, a description of the highway, vehicles, drivers, and occupants involved, a narrative of the sequence of events of the collision including details of the precrash, crash, and postcrash phases, an assessment of injuries and damage, and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

Office of Accident Investigation and Data Analysis, National Hwy. Traffic Safety Administration
1976; 346p
Availability: NTIS

HS-801 927

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES VOL. 7, NO. 6

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident, a description of the highway, vehicles, drivers, and occupants involved, a narrative of the sequence of events of the collision including details of the precrash, crash, and postcrash phases, an assessment of injuries and damage, and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

Office of Accident Investigation and Data Analysis, National Hwy. Traffic Safety Administration
1976; 344p
Availability: NTIS

HS-802 002

LIFE SAVING POTENTIAL OF GREATER SAFETY BELT USAGE

A standardized procedure for examining the effect of safety-belt usage upon traffic fatalities in the U.S. is described and documented. Estimates for calendar year 1975 are made based on the procedure and on the NHTSA Fatal Accident Reporting System File (FARS). Data and results examining seat-belt usage and effectiveness are broken out by model year since at any given time, a sample of automobiles on the roads will include varying numbers of representatives of different model years, and different model years are equipped with different standard equipment. Seat belts were not mandatory in passenger cars prior to the 1964 model year. Beginning with the 1964 model, lap belts only were installed by mandate. In the 1968 model year, the shoulder belt for the front outboard position became an additional requirement to the lap belt. The 1973 model cars utilized a continuous buzzer that could only be deactivated by fastening the seat belt. In 1974 models, the continuous buzzer was replaced by the ignition interlock system. Also beginning in 1974, the shoulder harness was permanently fastened to the lap belt, forming a three-point system. The NHTSA's FARS currently contains information on approximately 90.9% of the fatal accidents which occurred in the U.S. in 1975. Of the 22,835 fatalities who were occupants of passenger cars, 20,976 were occupants of cars of model years 1964-1976, years in which seat belts were mandatory. This report focuses on the 20,976 fatalities among occupants of passenger cars for these model years. Tables presented describe: seat-belt usage in passenger cars in 1975; seat-belt effectiveness rates; a distribution of estimated actual traffic fatalities by model year 1975; assumed usage rates by model year and restraint type; estimated actual deaths to passenger vehicle occupants in 1975 versus those that would have occurred had there been no belt usage; hypothetical deaths to passenger vehicle occupants in 1975 at seat-belt usage zero versus 60%, 80%, and 100% usage rates; total deaths to passenger vehicle occupants in 1975 at seat belt usage zero, current seat belt usage, 80% seat belt usage, and 100% seat belt usage. The study concludes that in the year 1975, traffic fatalities would have been 12.88% higher had there been no seat-belt usage. In comparison to a 0% usage rate, fatalities would have been reduced 26.32% if seat-belt usage had been 60%, 35.05% if seat-belt usage had been 80%, and 43.78% if seat-belt usage had been 100%. In the year 1975, traffic fatalities could have been reduced from the number of estimated actual fatalities by 16.83% had there been 60% seat-belt usage. In the year 1975, traffic fatalities could have been reduced from the number of estimated actual fatalities by 26.68% had there been 80% seat-belt usage. In the year 1975, traffic fatalities could have been reduced from the number of estimated actual fatalities by 36.54% had there been 100% seat-belt usage. Programs are included which were used to compute data for tables.

by Kathy Pappas Jatras
Office of Statistics and Analysis, National Hwy. Traffic Safety Administration
1976; 33p 2refs
Availability: NHTSA

HS-802 003

SLED TEST COMPARISONS BETWEEN THREE TYPES OF HUMAN SURROGATES. FINAL REPORT

This experimental test program included seven sled tests using one unembalmed cadaver and three anthropomorphic test dummies to compare motions, during impact testing, between a near 50th percentile cadaver and two types of anthropomorphic test dummies of 50th percentile size and weight. The tests were conducted on the Calspan HYGE sled facility simulating 30 mph frontal collisions in a subcompact car. A three-point belt restraint system developed by the Citroen Corporation was used. All dummies displayed lower head rotation and rotational velocity than the cadaver. The cadaver exhibited no head injuries. Chest acceleration measurements were approximately the same on the dummies and cadaver. The cadaver had fatal chest and upper abdominal organ injuries. Chest deflection measurements indicated that the GM 502DX dummy produces a chest deflection more like the cadaver, attributable to that dummy's softer chest. Post test autopsy on the cadaver found a flail chest and lacerated liver, as well as very high arterial pressure. Chest deflection, therefore, may be a more meaningful base for future injury criteria. There is a reasonable correlation between a near 50th percentile male cadaver and two types of anthropomorphic dummies in essentially identical crash simulations. There is a need for better definitions of human tolerance levels (in the areas of head rotation and rotational velocity and acceleration, with respect to effects on the brain, nervous system, musculature, ligamenture and bony structure of the spine) and their correlation with measurable quantities on both the cadaver and dummies. Test equipment and procedures and engineering test data are described in detail. There are three appendices detailing information on the sled test facility, the data gathering, recording and reduction system, and the time histories of the tests.

by Michael J. Walsh
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-5-01017
Rept. No. ZP-5852-V-2; 1976; 119p
Rept. for Dec 1975-Jan 1976.
Availability: NTIS

HS-802 005

DEVELOPMENT OF A UNITIZED SCHOOL BUS, VOL. 2. FINAL TECHNICAL REPORT

The development of new design concepts for school bus body structures and for passively restraining school bus passengers were the major objectives of this program. Passenger protection in front and rear rigid barrier impacts and in a side impact with a rigid pole - all at a 30 mph impact velocity - were the design goals. A unitized bus configuration was specified wherein the body and chassis frame are a single integrated structure in contrast to the typical school bus configuration where the body is bolted onto a chassis frame. The tests indicated that increased levels of occupant protection and improved structural crashworthiness could be provided with a unitized bus design but that this incurs cost and weight increases over a typical 66-passenger school bus. The handling performance of a unitized school bus would be equal to or better than a typical school bus because of the lower center of gravity. Design layouts of a 55-passenger operational school bus incorporating the unitized body structure and passive restraint systems were prepared. Modifications were made in the following systems: padding materials, seat back structure and knee restraint liner, arm rest, window assembly, interior surface, heating and ventilating unit, external lights and signals, exits, fire extinguisher, first aid and emergency equipment, and the electrical system.

by L. Adams; A. Khadilkar; L. Pauls; W. Rup
AMF Advanced Systems Lab., 495 South Fairview Ave., Goleta, Calif. 93017
Contract DOT-HS-4-00969
1976; 559p 45refs
Rept. for Jun 1974-Apr 1976. For summary rept., see Vol. 1, HS-802 004.
Availability: NTIS

HS-802 009

COMPACT AUTOMATIC VEHICLE CONTROLLER OPERATION AND MAINTENANCE MANUAL. FINAL REPORT

A new compact automatic vehicle controller (CAVC) was designed, built, and checked out based upon a weight reduction study of the conventional NHTSA automatic vehicle controller in response to meeting needs in the national trend toward smaller vehicles. The new controller also features electronic components that are more temperature stable than those used in the previous controller. This manual provides installation, operation, maintenance, and technical information for the CAVC, written at a level allowing immediate application of the system by moderately experienced personnel. The CAVC automatically controls an automobile incorporating five basic functions: braking, steering, throttle, clutch, and fifth wheel; and is controlled by preselected inputs from an electronic controller. Desired vehicle maneuvers can be initiated locally by an on-board driver or remotely through radio controlled commands from another vehicle. Major components of the CAVC include: electronic controller, brake actuator, throttle actuator, steering actuator, clutch actuator, pressure-compensated variable-displacement hydraulic pump, hydraulic fluid reservoir, hydraulic accumulator package, fifth-wheel and lift assembly. Troubleshooting of the system is instructed on the theory of CAVC operation, calibration, test procedures, and diagnostic aids. The manual also provides drawings, wiring diagrams, and a detailed description of all components.

Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle Peak Rd., Phoenix, Ariz. 85027
Contract DOT-HS-4-00853
Rept. No. UI-8256-76-14; 1976; 87p
Rept. for Jan 1976-Mar 1976.
Availability: NTIS

HS-802 010

AUTOMOBILE CONSUMER INFORMATION CRASH TEST PROGRAM, VOL. 1. FINAL REPORT. SUMMARY

by N. E. Shoemaker; M. O. Ryder; N. J. DeLeys
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00910
Rept. No. ZT-5561-V-30; 1976; 26p 5refs
For abstract, see Vol. 2, HS-802 011. Individual test reports are published as separate documents.
Availability: NTIS

HS-802 011

AUTOMOBILE CONSUMER INFORMATION CRASH TEST PROGRAM, VOL. 2. FINAL TECHNICAL REPORT

Experimental test data were generated on recent intermediate-size automobiles in the areas of damage susceptibility, crashworthiness, and repairability and the capability of existing simulation models for predicting the dynamic responses of the vehicles and occupants. The full-scale crash testing program included frontal barrier and car to car front-to-side and front-to-rear impacts in 22 tests of 1973 and 1974 models of Plymouth Satellite and Ford Torino vehicles. Ten tests that included 15 and 30 mph collisions against a fixed rigid barrier, 20 mph car-to-car, front-to-side and front-to-rear impacts, and 15 mph rear impacts by a moving rigid barrier were performed in Phase one. The 1974 model vehicles in the Phase two test program were subjected to eight, twenty-five, thirty, and thirty-five mph collisions with the rigid barrier and front-to-rear impacts of cars of the same make in which the rear of the stationary target vehicle was struck by the other car at speeds of ten and twenty mph. Individual test reports were published during the course of the research project; the test configurations and corresponding reports are listed in Tables one and two for the Phase one and Phase two tests, respectively. The following are some of the conclusions which were developed from results of the crash testing and mathematical modeling efforts applied in the research program: much of the requested data generated within the crash test program are regarded as being of little or no value for comparative evaluations and rating of vehicle collision performance; side and rear impact testing for comparison and ranking of crashworthiness and damageability performance of different vehicle make/models should be accomplished with identical "bullet" vehicles such as a moving barrier; the crash test data indicate little difference between the two makes of cars with respect to crash-

produce significant differences in test results. It is recommended that the number of tests be reduced by eliminating one or more of the test speeds; the vehicle structure and occupant response simulation efforts described in the report must be regarded as inconclusive with respect to having demonstrated the feasibility of using predictive techniques as the basis for evaluation and rating of automobile crashworthiness performance. However, the comparisons of analytical and experimental results do support the conclusion that the models offer considerable potential for economically generating useful data to aid in the evaluation process.

by N. E.Shoemaker; M. O. Ryder; N. J. DeLeys
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00910
Rept. No. ZT-5561-V-29; 1976; 268p 10refs
For summary rept., see Vol. 1, HS-802 010. Individual test reports are published as separate documents. Rept. for Jun 1974-Jan 1976.
Availability: NTIS

HS-802 014

ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION, PHASE 3, VOL. 1. FINAL REPORT

The results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems are described. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given. Results of the baseband radar hardware evaluation show that the target detection performance for automotive targets is acceptable. The system is also simple, low cost, and has minimal radiation hazards. The major problem is broad antenna coverage, unacceptably wide for automotive braking sensors. If coverage can be narrowed to five degrees or less, the system should be considered. The simplest solution for acceptable performance in rainfall will be the use of pulsed radar systems. The blinding study for multiple vehicles demonstrates that the probability of blinding is increased somewhat for a multiple vehicle encounter, but it is not significant. Antenna pattern effects would reduce even this level so it is concluded that multiple-vehicle blinding is improbable. Study of range limiting techniques for reducing false alarms on curves showed that reduced range in curves is a promising technique. The study recommends that a prototype pulsed system designed for automotive applications should be built, since the pulsed systems have a number of advantages over other types of radar. Two figures show the comparative radar signatures of a bicyclist, motorcyclist and a station wagon, and the maximum range v. rainfall rate. Two tables show signals from various targets in decibels, and the minimum required signal-to-noise ratios for different radar systems--pulsed, diplex Doppler, and FM-CW.

by R. A. Chandler; L. A. Jacobson
Department of Commerce, Inst. for Telecommunication Sciences, Boulder, Colo. 80302
Contract DOT-HS-5-01096
1976; 32p 3refs
Rept. for Mar-Dec 1975. Vol. 2 is HS-802 015.
Availability: NTIS

HS-802 015

ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION, PHASE 3, VOL. 2. FINAL REPORT

The results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems are described. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given. Results of the baseband radar hardware evaluation show that the target detection performance for automotive targets is acceptable. The system is also simple, low cost and has minimal radiation hazards. The major problem is broad antenna coverage, unacceptably wide for automotive braking sensors. If coverage can be narrowed to five degrees or less, the system should be considered. The simplest solution for acceptable performance in rainfall will be the use of pulsed radar systems. The blinding study for multiple vehicles demonstrates that the probability of blinding is increased somewhat for a multiple vehicle encounter, but it is not significant. Antenna pattern effects would reduce even this level so it is concluded that multiple-vehicle blinding is improbable. Study of range limiting techniques for reducing false alarms on curves showed that reduced range in curves is a promising technique. The study recommends that a prototype pulsed system designed for automotive applications should be built, since the pulsed systems have a number of advantages over other types of radar. The report contains 18 figures, nine of them showing radar signatures of various automobiles and one showing comparative signatures of a bicyclist, motorcyclist and a station wagon, elliptical regions observed by gated binaural system, effects of rainfall upon radar performance (four figures) and four figures illustrating signal level v. off-boresight angle at different curves and with both uniform and cosine aperture illumination. The two tables show the signals from various targets in decibels, and the minimum required signal-to-noise ratios for different radar systems--pulsed, diplex Doppler and FM-CW.

by R. A. Chandler; L. A. Jacobson
Department of Commerce, Inst. for Telecommunication Sciences, Boulder, Colo.
Contract DOT-HS-5-01096
1976; 63p 9refs
Rept. for Mar 1975 - Dec 1975. Vol. 1 is HS-802 014.
Availability: NTIS

HS-802 016

PASSENGER CAR BRAKING PERFORMANCE, VOL. I. FINAL SUMMARY REPORT

by Arnold Gilchrist; Bert Enserink
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle Peak Rd., Phoenix, Ariz. 85027
Contract DOT-HS-4-00932
Rept. No. UI-8274-76-12; 1976; 32p 6refs
For abstract, see Vol. 2, HS-802 017. Rept. for Jun 1974-Feb 1976.
Availability: NTIS

HS-802 017

PASSENGER CAR BRAKING PERFORMANCE, VOL. 2. FINAL TECHNICAL REPORT

A program was carried out to determine the current braking capabilities of passenger cars in terms of Federal Motor Safety Standard (FMVSS) 105-75, to determine the direction and rate of evolution of passenger-car braking performance, to examine the braking performance standards with respect to tests, test conditions, sequences, and performance requirements, and to recommend changes in the current standards and/or propose new standards to correct any deficiencies noted in the study. The current state-of-the-art of passenger-car braking was determined from information gathered both from literature and from testing conducted within the program. In order to extend the data base for evaluating the state-of-the-art, five vehicles were selected for testing in the program. The selection criteria established by the contract were as follows: one vehicle was chosen from each of the five classes of subcompact, compact, intermediate, full size, and performance specialty groups; the vehicles selected were representative of a top performing car in each group; and only one of the vehicles was of foreign manufacture with the remaining four selected from the four major domestic manufacturers. The 1974 Fiat 124 Sport was selected for the subcompact class. This car had four-wheel disc brakes and a load-sensing proportioning system and was reported by the enthusiast magazines to have good brake performance. A 1974 Plymouth Duster was selected to represent the compact class. Sales for this vehicle, when added to the Dart, a functionally identical vehicle, are the highest for any vehicle in this class. The car tested was a V-8 with front disc and rear duo-servo drum brakes. The booster was vacuum powered. A 1974 American Motors Matador station wagon represented the intermediate class and was also equipped with front disc, rear duo-servo drum brakes and a vacuum booster. A 1975 Lincoln Continental Mark IV was chosen to represent the full-sized category because it had the most advanced brake system of any full-sized vehicle. It had four-wheel disc brakes, a drive shaft controlled, hydraulically powered antilock system, and a hydraulically powered booster. A 1975 Chevrolet Monza V-8 was chosen from the performance specialty group. The vehicle was equipped with vacuum assist and nonventilated front disc brakes plus leading-trailing shoe rear drum brakes. A diagram is provided which shows the results obtained with the five cars on the various effectiveness tests, compared to the requirements of FMVSS 105-75. The test results obtained on the five vehicles indicate that the requirements of FMVSS 105-75 are reasonable and well within the current state of the art in braking technology. Stability, steerability, maximum stopping distance, stopping distance in partially failed condition, heat and water fade, and parking brake capabilities were conditions tested for by the investigators. Stability and steerability were found to be important safety-related braking performance parameters not directly covered by the current standard. It is recommended that straightline stopping performance be specified in terms of braking efficiency in order to normalize braking performance values for tire and roadway frictional characteristics. Appendices present test data summaries on the five autos tested, a description of a two-way proportioning analysis to review the methods used in distributing the brake forces between front and rear axle and a description of special tests conducted, and the investigators' recommended next generation standard for passenger-car brakes.

by Arnold Gilchrist; Bert Enserink
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle Peak Rd., Phoenix, Ariz. 85027
Contract DOT-HS-4-00932
Rept. No. UI-8274-76-4; 1976; 229p 25refs
For summary rept., see Vol. 1, HS-802 016. Rept. for Jun 1974-Feb 1976.
Availability: NTIS

HS-802 019

COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION--PHASE 2, STUDY. VOL. 1. FINAL SUMMARY REPORT

by Richard E. Wong; W. R. Faris; W. O. Grierson; W. C. Troll; Y. M. Powell; D. V. Payne
Bendix Corp., Bendix Res. Labs., Southfield, Mich. 48076
Contract DOT-HS-4-00913
Rept. No. BC-8035; 1976; 54p
For abstract, see Vol. 2, HS-802 020. Rept. for May 1975-Jan 1976.
Availability: NTIS

HS-802 020

COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION--PHASE 2, STUDY. VOL. 2--FINAL TECHNICAL REPORT

An instrumented test car equipped with an automatic/noncooperative radar brake system was used to gather and classify experimental data on radar false alarms as a function of various radar system parameters, such as: detection range cutoff (RCO), antenna beamwidth, range delay, and vehicle velocity. The test vehicle was driven over three roadways under actual traffic conditions within the metropolitan area of Detroit, Mich., typifying much of the high-density, high-speed, urban, and suburban driving in the U.S. Results of the test program showed that both detection RCO and antenna beamwidth have a pronounced effect upon the false alarm problem; range delay and vehicle velocity are of secondary importance. Analytical analyses were also performed to determine effects of radar design parameters such as beamwidth and frequency on rain clutter and radar detection probability for three target classifications ranging from pedestrians to full-size passenger cars. A computer simulation program was employed to evaluate the system cost-effectiveness of 36 system configurations. The effects of changing system design parameters and operational differences within each system are also examined. The 1973 traffic accident data sources representing six states and six counties were selected to provide the largest practical data base and to reduce biases due to geographic, economic, and reporting agency influences. System evaluation was made in a comparative form to show the estimated value to society over the lifetime of the vehicle and benefits were estimated in reduction of fatalities, injuries, and property damage: an automatic/noncooperative radar brake system, satisfying the preliminary system performance specification, could result in preventing approximately 18% of all traffic accidents nationwide, and approximately 15% of lives involved in fatal traffic accidents annually. Subject to the assumptions made in the study, results indicate that an automatic/noncooperative radar brake system can be designed

which could effectively suppress the false alarms due to non-hazardous targets and still be cost-effective in reducing motor traffic accidents. Primary problems remaining are to demonstrate installation feasibility of such an anticipatory braking system in a variety of motor vehicles ranging in size and to resolve the need for a four-wheel anti-lock system as a requirement in conjunction with the automatic radar braking system. An attached computer listing illustrates the program used for the sensitivity analysis.

by Richard E. Wong; W. R. Faris; W. O. Grierson; W. C. Troll; Y. M. Powell; D. V. Payne
Bendix Corp., Bendix Res. Labs., Southfield, Mich. 48076
Contract DOT-HS-4-00913
Rept. No. BC-TR-8035; 1976; 186p 45refs
Rept. for May 1975-Jan 1976. For Summary rept., see Vol. 1, HS-802 019.
Availability: NTIS

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